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Index

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The Science Counselor

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HELP FOR SCIENCE TEACHERS

For twelve years Duquesne University has published this journal to help science teachers everywhere become more alert, more enthusiastic, and more skilful teachers, and persons better informed about the latest developments in science and education. The field of endeavor is a broad one. It is for this reason that the *Science Counselor* invites active researchers in science, school executives, leading industrialists, and outstanding public figures, as well as science teachers in service, to address its readers. It limits itself to no level of teaching and to no single field of science. It desires to stimulate, to inform, to assist, to advise.

The word *Counselor* indicates this purpose. You may consult us freely. Perhaps you seek advice in selecting a textbook or aid in purchasing laboratory furniture, equipment, or supplies. You might want information about a scientific society, a school where certain courses are taught, what teaching aids are available. You may have other classroom, laboratory, library, or administrative problems. To assist you in your daily tasks and to help you become more successful teachers we put at your gracious command not only the interested and courteous counseling service of the *Science Counselor's* editorial staff, but also of the specialists in Duquesne University's science departments, its library personnel, and its professional faculties, including the school of education. You may feel free to take advantage of this unusual educational service whenever you are faced by a puzzling academic problem. We shall try to give you wise Counsel.

H.C.M.

Science—Learning vs. Using

• By Ralph H. Upson, M.E., Ae.E. *(Stevens Institute of Technology)*
PROFESSOR OF AERONAUTICAL ENGINEERING, UNIVERSITY OF MINNESOTA, MINNEAPOLIS, MINNESOTA

The writer of this thoughtful article has observed that the outstanding shortcoming of college students is the inability to think a problem through from basic principles. Mental training, therefore, can well become the paramount object of elementary science training.

The facts, principles, and results of science will be effective to the extent that the student can be induced to use them for his own mental development. "Real science, unused, is little better than pseudo-science".

In 1929 the American Society of Mechanical Engineers conferred on Mr. Upson an award for "outstanding service rendered aeronautics." In 1930 he received the Wright Brothers medal from the Society of Automotive Engineers.

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This title seems to imply the time-honored, and hardly to be disputed, premise that the best way to learn science is to use it. If that were all, we could doubtless agree on this plainly acceptable principle at the start and dispense with the rest of the article. But sooner or later we should have to decide what we mean by the words "learning" and "using".

Many *learned* discussions have been written on such questions as: What is true *learning?* What should distinguish a *learned* person? What constitutes the process of *learning?* Here, for convenience, we shall sidestep the abstract philosophical implications of these questions, and take learning in its narrow sense as meaning simply the process of absorbing knowledge. In this sense, there seems no great room for misunderstanding, at least within the bounds of science learning. But, strangely enough, the apparently simpler word "using" seems still harder to pin down. Many and varied are the questions that it implies. In connection with the present subject, for instance:

Does *using* refer to the facts, principles or the results of science?

Are such items to be handed down by the teacher, dug out by the individual student, or studied as a group effort?

Should the principal approach be historical, analytical or sensory?

Is using concerned with deriving, experimentally demonstrating or applying the major theorems?

Does it mean student use of laboratory equipment?

Or does it mean classroom demonstrations of scientific tricks by the teacher?

There has recently been considerable discussion as to whether elementary science courses *on the college level* should be any different for a science major than for a student not going on into science or engineering. At least three arguments have been advanced for making them the same:

1. Even the beginning college student often does not know whether he wants to follow a scientific career or not, and such courses should be planned to facilitate his choice.
2. Students going on into scientific work need even more the broad background of science in its relation to life itself which is presumably a principal point of interest of the non-science majors. To quote Professor Taylor of Oberlin, "To deprive the former of such advantages because of their plans for a scientific career is throwing out the baby with the bath."
3. It has been claimed that the primary object of *all* education should be to teach students to think. The validity of such a broad statement may be seriously questioned; but hardly if we substitute *beginning science* for *all.* And the attainment of this object is apparently for the most part concerned with the normal functioning of human beings rather than of engineering students as such.

Experience with engineering graduates shows that their most common lack is ability to think a problem through from basic principles. In other words, what they need *most* is not "tricks of the trade," but the same kind of elementary grounding that should be given any science student.

Although such reasoning has been challenged in part, if it has any validity for college students, how much more compelling it is for students in secondary schools! And of all these considerations, the third seems to hold the real key to the situation; for who can deny that the paramount object should be the development of the student's own mental processes? This then will be our point of departure for further discussion.

This emphasis on mental training is certainly nothing new. It has been the attempted justification (rightly or wrongly) for nearly every course ever offered that lacks direct practical utility; history, literature, Latin, Greek, and various branches of science, including most of mathematics, to name the more common ex-

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Sunspots and Radio Waves

• **By Harlan T. Stetson, Ph.D.** *(University of Chicago)*
DIRECTOR, COSMIC TERRESTIAL RESEARCH LABORATORY, NEEDHAM, MASS.

Not all of us were aware of it, but in 1947 the world passed through a period of maximum sunspot activity. What effects were produced on the world and its atmosphere? How was radio reception affected? Can the effect be explained? What influence do sunspots have on the abundance of electrons in the upper atmosphere? What do auroras mean to the radio engineer?

Dr. Stetson's brief account of a remarkable solar phenomenon and its terrestial influence will stimulate interest in this distinguished scientist's latest book, "Sunspots in Action", which is reviewed elsewhere in this number.

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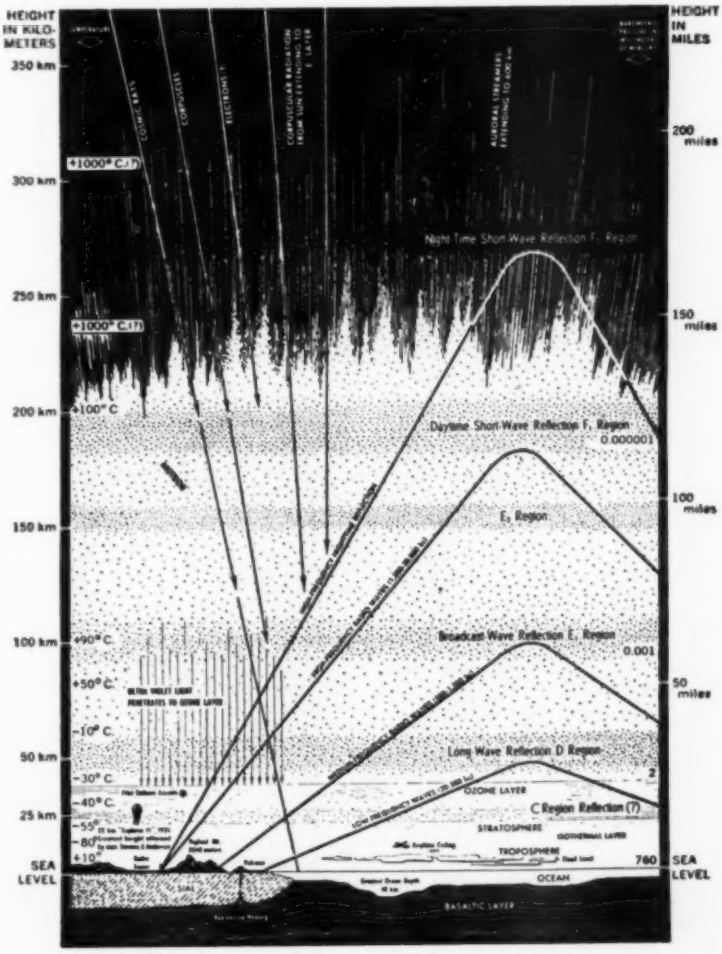
Sunspots have been regularly observed almost since their discovery with the telescope by Galileo in the year 1610, and we have reliable counts of sunspots since the year 1750. It is only in the last two decades, however, that the importance of sunspots to us on the earth has become apparent. This came about largely through the development of wireless and radio communications.

When sunspots make headlines in the news, it is usually because of the conspicuous effects which they cause on the earth and its atmosphere. Displays of Northern Lights, interruptions to telephone and telegraph lines, and blackout in radio transmission are events which make us more and more aware of the part played by the sun in the activities of man.

When a storm is raging in the sun's atmosphere akin to a tropical hurricane on the earth, we must remember that this is a solar disturbance a million times more consequential than the most devastating twister that the earth's atmosphere can manufacture. Since the sun is roughly a million times as big as the earth, these sunspots, which are veritable hurricanes in the sun's atmosphere, are proportionately a million times bigger than any hurricanes which have ever visited and devastated Florida real estate.

To understand how sunspots interfere with radio communication we need to take a look at a cross-section of the earth's atmosphere and see how radio waves travel. When a distant broadcasting station sends out its program, electromagnetic waves spread out in all directions from the antenna like the waves circling in a pond or lake about a pebble that is dropped. Some of these waves from the broadcasting antenna travel directly over the earth's surface and are known as ground waves. They do not, however, travel very far and may be completely lost 50 miles from the transmitting station. Others of the waves travel skywards until they meet a spherical shell of electrified particles from 70-100 miles or more above the earth. Two conspicuous layers of electrified particles in the atmosphere are recognized by radio engineers. The E layer, sometimes called



CROSS SECTION of the earth's atmosphere, showing how radio waves of various frequencies bound back from the ionized layers. (From *Sunspots in Action*, Stetson. The Ronald Press.)

DR. HARLAN T. STETSON marks a sudden drop in radio reception on a recorder measuring radio field intensities at the Cosmic Terrestial Research Laboratory, Needham, Mass.

the Kennelly-Heaviside layer, which turns back waves of broadcast frequency at about 70 miles above the earth, and the F layer, otherwise known as the Appleton layer, some 150 miles high, which turns back the waves of shorter frequency.

Scientists picture that these electrified or ionized regions of the atmosphere are maintained by the ultraviolet light of the sun shining upon the oxygen molecules which may dissociate one or more electrons and hence ionize the atoms, making them electrically conducting. Other things being equal, the greater the number of ions and electrons in these stratified layers, the more perfectly will the radio waves be reflected back to earth and picked up at points remote from the broadcasting antenna. This is what makes long distance reception possible. Were it not for sunlight falling upon these outer regions of the earth's atmosphere, we should be lacking such reflecting surfaces, and our radio programs would indeed be limited to the range of the ground wave.

There is every reason to believe that in some mysterious way the ionizing radiation from the sun during the time of most sunspots is about twice as effective in creating electrons in the upper air as during the time when sunspots are scarce and infrequent. Every student of astronomy knows that there is a period of about ten or eleven years in which sunspots rise to a peak of maximum activity and then subside. We have just passed a period of maximum sunspot activity in 1947. In fact, so large and so numerous were the sunspots that the solar index familiar to astronomers as the "Zurich sunspot number" exceeded any value recorded since the year 1778.

Those who have followed the problem of radio communication frequencies know that for a given time of day during a given season of the year, the frequencies to be used by radio engineers are vastly different at a sunspot maximum than they are at a sunspot minimum. It is therefore becoming a matter of practical engineering importance to predict outbreaks of sunspots in advance, so that communication companies may make their plans for oceanic traffic on frequencies or wave lengths that will be most effective to render satisfactory communication

During periods of maximum sunspot activity, there are times when it appears that some gigantic explosion takes place on the sun, liberating an enormous amount of energy similar to that which might be liberated with the explosion of a solar atomic bomb. The radiation rushing towards the earth from such a solar catastrophe so completely upsets the ionized layers that all radio communication may be blacked out for from 15 minutes to an hour or more when such a solar cataclysm has taken place. On certain definite occasions brilliant bursts of hydrogen flames have been seen in the spectroscope or photographed with the spectrohelioscope, coincident with the time when communication by radio has been momentarily blacked out.

There is also another kind of disturbance from the sun which may be anticipated with increased solar activity that may affect radio and ionization of the upper atmosphere for not only hours but days. We have good reason to believe that when very large sunspots occur, electrified particles are shot out from the region of these sunspots at very high velocities and that in the course of 24 to 36 hours these penetrate the earth's atmosphere, causing unusual conditions of ionization. If the bombardment of the upper air is sufficiently intense, a glow discharge occurs the following night, producing what we know familiarly as the Northern Lights or the auroras. When auroras occur, you may

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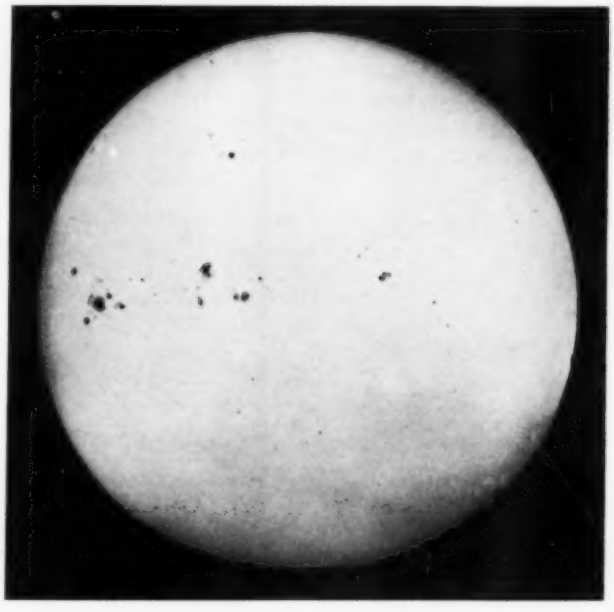

THE SPOTTED SUN ON MAY 8, 1948.

Whole Education for the Complete American

• **By Franklin J. Keller, Ph.D.** *(New York University)*
PRINCIPAL, METROPOLITAN VOCATIONAL HIGH SCHOOL, NEW YORK CITY.
RECENTLY HEAD, VOCATIONAL AND TECHNICAL SECTION, EDUCATION AND RELIGIOUS AFFAIRS BRANCH, AMERICAN MILITARY GOVERNMENT IN GERMANY

Vocational education has come of age. It is no longer in the trade school stage. It is concerned not only with learning by doing, but also with preparation for living, with the coordination of school and adult life. Courses of study have been enriched and extended so that a sound education is now provided.

Dr. Keller bases his discussion on quotations from the recently published "Education for an Industrial Age". After reading his comments, you will want to read the whole book.

●

Of all types of education, vocational education is the oldest. Primitive man teaching his son to shape a spearhead, primitive woman showing her daughter how to cook — fundamental operations like these were once necessary for survival. They were learned in one way or another, most often informally, by trial and error. Eventually they were taught by planned, organized arrangements such as apprenticeship, factory schools, shop courses in academic schools, and finally by full-time vocational high schools and colleges.

With advances in science and their application to industry such education has called for a vast variety of content, a high degree of mechanical skill, and great understanding. Indeed, those institutions fostering this kind of preparation for life have often been accused of "vocationalism" and "specialism" with the implication that these constituted highly reprehensible crimes against youth and society. It is, therefore, refreshing to see the problem treated realistically (in terms of the work that people do in the United States today) and idealistically (in terms of what our boys and girls should be able to do not only for its survival value but for its contribution to the whole, the good life).* "As here conceived," say the authors, "vocational education does not compete with the goals of a truly humanistic education; on the contrary, it embodies some of the latter's oldest and soundest principles—learning by doing, preparation for life, and the integration of education with the actual social process."

Education for an Industrial Age is in reality the very outgrowth of science. It is what people do about and with science. It is the way they use this knowledge about nature for more abundant living. They tend the good earth so that it may provide more and better food. They disembowel the rocks for sources of warmth and power. They master water and air so that they may move about and meet their fellow-men. What people do, they call agriculture and mining and manufacturing and transportation and, that everybody may benefit from the products, business. An industrial age is an age of infinite variety, of many kinds of doing that must be learned. These doings provide those ideal conditions for which every competent science teacher yearns, where each pupil is motivated by a desire to do something for which scientific knowledge is necessary, and makes such knowledge part of himself because he has used it for his own purposes. As our authors point out, science becomes even more vital in the academic school:

> "To some extent, all in-school vocational education and training includes fields that are considered the province of general education, such as mathematics and science. All occupations in the metal, machine, and electrical industries, for example, involve applied science and presuppose a knowledge of mathematics. Preparation for these occupations, if conceived in broad terms, must therefore accord these subjects at least the same emphasis given them in general education. Indeed, for these and a number of other trades, it would even be desirable to extend such instruction beyond the limits set by the general high school, in order to meet the student's interest and to establish a direct connection between his particular field of study and the general development of science and technology."

For many years "trade schools", as they were at first known, were handicapped in serving youth by the fact that many administrators and teachers in elementary schools considered school shops as appropriate "dumping grounds", with all the unpleasant associations of the phrase, for "non-academic minded" boys and girls. They lost sight of the notional potentialities of the deeply interested skilful person, and of the mechanical potentialities of the purposive scholarly person. Of late, these possibilities have been explored, with the result that some vocational high schools are not only preparing boys and girls for trades but are enabling many of them to enter college.

After outlining the organization of a complete vocational school system, Kähler and Hamburger state:

> "Since college preparatory courses would be included in vocational education programs, college would also be open to those desirous of pursuing their studies at the level of higher education. Such a system would have the advantage of securing technical mobility without sacrificing the opportunities for work on a craft level, and it would, in addition, overcome the rigid separation between craft, technical, and managerial positions—a result that must be regarded as de-

*Alfred Kähler and Ernest Hamburger, *Education for an Industrial Age*. Published for the Institute for World Affairs by the Cornell University Press, Ithaca and New York, 1948.

> sirable from technical, social, and political points of view . . . But a sound vocational education program does not prevent a student from getting a balanced general education. The danger of vocationalism exists only when the principles and aims of a fully rounded education are neglected. Indeed, if vocational education in its future development conscientiously assumes the duties of any truly organic education, its work may well proceed on a sounder basis than that of certain liberal arts programs which too, in their own way, run the risk of being dangerously narrow. Neither such programs nor any others can claim to be an integrating force unless they help the student to find and fill his proper niche in the social and economic life of our time."

That is the point: "Help the student to find and fill his proper niche in the social and economic life of our time." And "niche" is not conceived in any static sense, for, as noted above, occupational mobility is of paramount importance. Mobility, opportunity, is the essence of the American program, requiring a well-rounded, wholly integrated education, preparing for whatever life may offer in terms of the special interests, aptitudes and abilities of the individual. A sound educational program, whether it be called academic or vocational, can be serviceable to youth and society only if it provides for each individual as an individual. In other words, educational and vocational guidance must be part of its scheme. Our authors realize this. In making a painstaking analysis of industrial trends and occupational distribution they have provided invaluable occupational information. They would make available many different kinds of training for many different kinds of people, and they would provide rich tryout courses for the determination of individual traits. The whole matter of vocational guidance is fundamental to the success of any educational program. It involves not only consideration of the individual but of work itself, of the primacy of the person, of motivation and interest, of thinking and intelligence. These factors do not come within the scope of "Education for an Industrial Age" but they are dealt with at length elsewhere.*

Being products of the German school system, Messrs Kähler and Hamburger are fully conscious of its conservative nature. For instance, not more than eight per cent of 14 to 18 year old German youth ever get into full-time high schools. This contrasts with approximately seventy per cent in the United States. The other ninety-two per cent go to work, many of them as apprentices, and receive four to eight hours a week of instruction in subjects related to their trades, with scant attention given to the social studies. The authors are emphatic as to the need for full-time instruction for this age group.

> "Although in-school vocational and technical education cannot be considered either an alternative to apprentice training or a substitute for training on the job, it undoubtedly constitutes the soundest foundation for both. Even if apprenticeship and systematic training on the job were available to a greater extent than they are now, vocational and technical high schools would still be urgently needed to provide the educational background . . . The statistical comparison of the percentage of high school population attending vocational high schools with the percentage of the total labor force engaged in manual and technical pursuits makes it abundantly clear that the vast majority of persons working in the trades and industry have had no systematic in-school preparation. The number of persons enrolled in vocational high schools and preparing for the craft trades far from meets replacement needs in the field of craftsmanship which remains so vital a factor in modern production."

The vocational school must not only prepare for initial occupations, it must graduate pupils who will ultimately be able to fill the highest jobs in industry. Indeed this is true of any type of school which boys and girls leave to go to work. These schools must provide training in the traditional trades and also for those jobs that have recently developed and require new and high skills.

> "The whole task of occupational training would be greatly facilitated by the organized annual transfer of school-leaving youth into industry. Such a project would, of course, be a formidable undertaking, and could be accomplished only with the cooperation of schools, management, and organized labor, working through the medium of the advisory boards. It would, however, go far toward solving the serious educational and social problem of launching youth on an occupational career without an interruption of years spent in dead-end jobs or possibly without employment. It would also enable the worker to derive the fullest advantage from his vocational preparation, and to develop his abilities and knowledges during the years when his flexibility and capacity for learning are at a peak. And beyond that, the probability of a promising job immediately after the completion of schooling would give meaning and inspiration to vocational education and training in school."

This statement applies, of course, to any kind of school and any kind of job—boys and girls, young men and women, leaving high school or college, sometimes as graduates. They now suffer from lack of coordination between school and adult life. One of the outstanding features of most vocational high schools is their guidance and placement of graduates through advisory boards of representatives of employers' and employees' organizations. This is another phase of the American thesis that the schools are the people's and can be effective only when operated in intimate cooperation with the people.

The genesis of *Education for an Industrial Age* lies in the interest of persons with a deep sense of responsibility for sound education for all the people. All the members of the faculty of the Institute of World Affairs, many of whom cooperated in this study, rebelled against the fantastic doctrines of the German Nazis and came to this country to work in and for the American scene. The very extensive and time-consum-

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*Franklin J. Keller. *Principles of Vocational Education.* Boston, D. C. Heath and Co., 1948.

The Teaching of Isotopes

• **By Mel Gorman, Ph.D.** *(Stanford University)*
DEPARTMENT OF CHEMISTRY, UNIVERSITY OF SAN FRANCISCO, SAN FRANCISCO, CALIFORNIA

This article continues a discussion of the teaching of isotopes begun by Dr. Gorman in our September, 1948, number.

Here he points out that the study of isotopes begun in freshman chemistry must not terminate with the course. Organic chemistry provides many opportunities for pertinent experiments and discussions. So do biochemistry, qualitative and quantitative analysis, and physical chemistry, if the instructor is interested and alert.

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Introduction

In a review of the methods of introducing the subject of isotopes used by authors of a number of freshman chemistry texts, the expanding importance of isotopism and its applications was emphasized.[1] It was noted also, that although isotopes are usually treated in the early portions of most books, continued study throughout the whole text of the existence and use of isotopes of important elements generally was not very extensive. Some briefly stated suggestions were made for more frequently calling to the attention of the student the phenomenon of isotopism, thus arousing a fuller appreciation of this subject by the end of a year's study of general chemistry.

Of course, such an appreciation soon would be lost if the study of isotopes terminated at the end of the freshman year. On the other hand, it could be intensified by further study in sophomore and upper division courses. It is the purpose of this paper to outline how some of the aspects of isotopism can be introduced into the various courses which are studied after the basic freshman course.

Applications to Organic Chemistry

The field of organic chemistry provides one of the key steps in the utilization of compounds labeled with radioactive isotopes. Organic compounds are of extreme importance in the approach to solving many problems in pure and applied science. For this reason, it would be well to discuss in the elementary organic course the means of synthesizing at least a few organic compounds containing C^{14}. This isotope stands out as perhaps the most generally useful in the field of biological and medical research, besides its fundamental importance in pure organic chemistry. It is produced by neutron bombardment of ammonium nitrate solution circulating through a chain reacting pile. It is collected as carbon dioxide and converted into barium carbonate, in which about 0.4 per cent of the carbon atoms are radioactive. In this form it is obtainable from the Atomic Energy Commission. Radioactive carbon dioxide, liberated in the usual manner by adding sulfuric acid, can be incorporated into organic compounds by conventional organic procedures. For instance, acetic acid containing carboxyl labeled C^{14} can be made by the Grignard synthesis. Similarly labeled derivatives of benzoic acid can be produced by the action of aryl halides on organolithium compounds, followed by carbonation. From the standpoint of organic chemical principles, nothing new is introduced by using the isotopic carbon. Consequently, the lecture time devoted to the inclusion of this description is very slight. But the advantage will lie in the fact that the introduction of syntheses using radioactive carbon (and other elements) will serve as a connecting bridge between the study of isotopes in freshman chemistry and the more detailed study of labeled compounds in advanced courses, such as biochemistry.

The use of isotopes in organic chemistry is not limited to synthetic applications. Many problems of interest to the organic chemist have been elucidated or solved completely by the use of radioactive and stable isotopes. Typical examples are racemization, followed with the aid of isotopic chlorine, and the Walden inversion, studied with radioactive iodine. A simpler type of mechanism study involves the use of water containing O^{18} in the hydrolysis of esters. For instance, in the hydrolysis of amyl acetate all of the heavy oxygen is found in the acetic acid. Although organic chemists had favored this mechanism for some time, definite proof came only through the use of the stable heavy oxygen isotope. A variety of other topics involving isotopes in organic chemistry is available, and it is suggested that the teacher of organic chemistry can select a few of these to present to his classes from time to time throughout the course. The student certainly will be impressed with the fact that isotopes are powerful tools in attacking some of the problems of organic chemistry.

In spite of the role which isotopes have played in the recent development of organic chemistry, and the fact that much of this role can be appreciated by students of even elementary organic chemistry, it is surprising that a number of organic texts do not mention isotopes, and most of those which mention them devote only two or three lines on one page to this subject. An outstanding exception is the book by Porter and Stewart[2]. In part of an introductory chapter, these authors present the fundamentals of isotopism in such a way as to review this subject as studied in freshman chemistry. By way of examples, five isotopes of carbon are described, including the half-lives and means of preparation of those which are not found in nature. The use of radioactive

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The Radio Tube and the Mathematician

• By Robert R. Seeber, Jr.
SENIOR STAFF MEMBER, DEPARTMENT OF PURE SCIENCE, INTERNATIONAL BUSINESS MACHINES CORPORATION, NEW YORK CITY.

Here is a new "electric brain" that solves in minutes or hours problems that formerly would require months or years for solution. This calculator, installed at the World Headquarters of the International Business Machines Corporation in New York City, is now available for demonstration and for the solution of appropriate problems.

It was designed and built under the direction of Mr. Frank E. Hamilton, senior engineer. Dr. Wallace J. Eckert, director of the IBM department of pure science and of the Watson Scientific Computing Laboratory, figured largely in the establishment of specifications for the machine, and serves as director of the research program which the calculator is handling.

The writer of this article served as chief assistant to Dr. Eckert and Mr. Hamilton in building the calculator. He is now in charge of its operation.

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The scene is laid inside a room whose walls contain a myriad of flickering tiny neon lights and thousands of glowing radio tubes. Along one wall are several drums supporting wide paper tapes with many small holes in them. Two of the drums are rotating, carrying the tapes with them. Their movement stops and another pair picks up the cadence. Many relays add their clicking rhythm. They have much work to do and are in a hurry to have it done. The sound of the mechanism seems somewhat remote behind the sliding doors.

Near the center of the room a mathematician is leaning over a printer, eagerly watching the type bars recording numerical solutions. A broad grin replaces his usual more thoughtful expression, for this is the exciting moment when the answers to his problem are beginning to arrive on the printed sheet. His excitement is something like that of the golfer who picks his ball from the cup on a hole-in-one. For the mathematician knows that the calculator is solving his problem in sixty hours. He knows that if he were to do it himself, fifteen years of work would find his problem still incomplete.

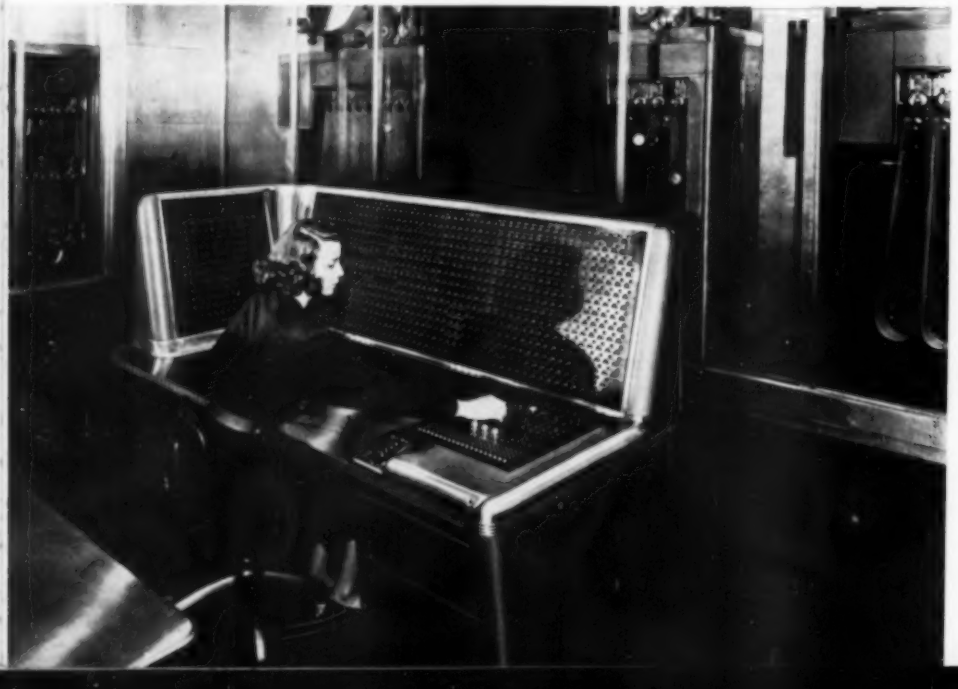
What means had made it possible for mathematicians and other scientists to have such a powerful tool available for their work? And why do they have need for it? One answer suffices for both questions. But let us go back to January 27, 1948, and hear the answer.

The scene is again inside the Calculator. Present is a large group of leaders in science, education, government, and business. The speaker is Mr. Thomas J. Watson, President of International Business Machines Corporation. He is saying:

> "As we stand within the structure of this new electronic calculator, I am moved by three related things. All three concern the scientists of our nation and of the world.
>
> First, I am deeply impressed with the scientific progress that has made necessary the construction of such a calculator.
>
> Second, I have profound admiration for the scientific progress that has made possible its construction.
>
> And, third, I am fully aware of the fact that this calculator is simply a small tool to assist in the work that our great scientists are carrying on for the benefit of mankind.
>
> It is with a mixed feeling of humility and confidence in the future, therefore, that I dedicate the IBM Selective Sequence Electronic Calculator to the use of science throughout the world."

Modern science in its deepening quest for truth finds itself ever more dependent on mathematics. This is true whether it is the atomic physicist searching out en-

CONSOLE, or operation indicator and control desk for the IBM *Selective Sequence Electronic Calculator*. At all stages of a computation progress may be seen by means of the indicator lights which show not only the unit in operation and the operation being performed, but also the results being achieved. Tape punching and reading units are seen in the background.



ergy levels, or the astronomer seeking new galaxies; whether it is the hydrodynamicist examining the turbulence in a stream of water, or the aerodynamicist streamlining an airplane; whether it is the meteorologist forecasting the weather, or perhaps even the physician combating disease.

Most of these problems are large and difficult. Many have never been formulated in mathematical terms before. Only the advent of high-speed calculating has made it possible to solve them at reasonable cost in a practical time.

Modern science has also given us the technological tools to meet these problems. To compute rapidly one must be able to count rapidly. For this the most important single element is the electronic, or radio tube. A pair of triodes can be coupled together so that one or the other, but not both, is activated or "conducting", the other being "cut off". Further, an electric pulse applied to the pair will change the status so that the triode that had been conducting will now be cut off and vice-versa. This then is the most elementary kind of counter. If the two triodes are called A and B and if we say that "zero" is represented when A is conducting and B is cut off, then we have a counter which will count from "zero" up to "one", "one" being represented by A cut off and B conducting. We cannot count very far with this combination because the second pulse will return it to the "zero" position. But if we couple the output to a second pair to count the number of times that the first pair goes back to the "zero" position, we can now count from "zero" to "three". The addition of two more pairs called the "four" pair and the "eight" pair, with suitable modifications, enables us to count from "zero" to "nine" and then return to "zero", at the same time "carrying" into the next column of the counter. Since we are counting electric pulses and since the tubes respond rapidly, calculation may proceed at very high speed. In fact fifty multiplications of pairs of fourteen-digit numbers can be accomplished in one second.

PRINTERS, which record at the rate of 24,000 digits a minute, give a running account of results produced by the IBM *Selective Sequence Electronic Calculator*. The scientist thus can follow the progress of a calculation and modify his program in the light of results as they are derived. This is of particular advantage because this calculator will be devoted largely to research problems in which the calculations cannot be planned completely in advance. Behind the sliding glass doors are seen some of the electronic tubes.

Besides the electronic circuits for adding, subtracting, multiplying and dividing, the Calculator brings numbers into the machine, records answers, and remembers intermediate results within the system until needed. Numbers enter the Calculator by punched holes on cards or tapes. Results are printed on paper or punched cards. Memory capacity is 400,000 digits, part in the form of tubes, part in high-speed electromagnetic relays, and part in punched tapes which can be re-read as required. By punching intermediate results in IBM cards the memory capacity can be almost without limit.

So complex a machine must be easily controlled lest its very purpose be defeated. A simplified system achieves this aim. The problem to be solved is broken down into elementary operations. Each line of instruction for the calculator represents a group of "addresses" employed in one of the elementary arithmetical operations. For example, it may be desired to compute $A \times B = C$. The instruction will indicate that the operation to be performed is multiplication; it will indicate the "address" of A, the multiplicand, which may be a number in a memory unit, or a number coming from a tape or card. Then there will be another similar address for B, the multiplier. The third address will tell where to deliver C after it is computed, perhaps back into memory, perhaps to the printer or punch. The successive lines of instruction are punched on cards or tapes as are the other numbers and are fed to the Calculator forming a sequence of instructions. There are ways of performing instructions repeatedly or, depending on some result in the computation, of exercising judgment in the choice between two sets of instructions.

What conclusions in the educational field are we to draw from this new Calculator? In the first place, it points up the serious need for additional well-trained personnel in the physical sciences. This seems like a paradox, for the calculator relieves scientists of routine computing. It leaves them free for more productive work. But many previously inaccessible fields of research now are being unlocked by modern computing. Now more than ever there is need for scientifically-trained personnel.

Within the computing field mathematicians are particularly needed. Here is a new and important field for students with mathematical aptitude. If they are brought into contact with this dynamic field as a goal they will be more purposeful in their basic training in arithmetic and elementary algebra. Already many high

(Continued on Page 151)

"Salt of the Earth"

• By William B. Wilkinson
SALES MANAGER, CAYUGA ROCK SALT COMPANY, INC., MYERS, N. Y.

Seldom is so much information, historical, literary, scientific, industrial, found in such a brief article. Here are facts you never knew—or if you did, you may have forgotten them.

There is romance in even so humble a material as salt. Use of some of the information given in this paper will liven your discussion of salt. Perhaps your students would be appreciative.

●

Salt, sodium chloride, is one of the physical essentials of life. If all the salt in our bodies were suddenly removed, we could not live 48 hours. Salt acts as a kind of policeman patroling our blood and keeping our body fluids in proper balance. We weep salt tears. Perspiration contains salt. So do the other fluids of the body. But by providing rich deposits all over the world, Mother Nature made sure that we will always be well supplied.

Salt is found in many sections of the United States. Especially rich deposits are located in Michigan, Ohio, West Virginia, Kansas, Texas, Louisiana, and Utah. Near Ithaca, N. Y., there are about 1,500,000 tons per acre. Russia, India, Poland, Germany, England and Ethiopia are well supplied. Japan has no known salt deposits. The location of salt springs and mines has influenced the distribution of the world's population. Towns and cities have sprung up, and nations have developed where salt is easily obtained.

Salt is as indispensable to modern industry as it is to health and life. We think of salt primarily as a food, but of the 14,000,000 tons produced in the United States annually, only a small percentage is consumed as table salt. Some is used in preserving foods. Large tonnages are needed by the fish-and meat-packing industries, and by dairymen, tanners, and soap makers. The great chemicals industries, however, are the greatest consumers, because sodium chloride is the cheapest and most plentiful source of sodium and chlorine, and of the many chemical compounds that contain one or both these elements.

From the earliest times man has realized the value of salt. Often he has employed it as a medium of exchange. Roman soldiers received a part of their pay, *salarium*, in the form of salt. This is the origin of our modern word salary, and of the expression "worth his salt." Among the old Chinese salt was considered second in value to gold, and it held an important place in the monetary system of the great Moguls. Marco Polo, in the 13th century, wrote that flat cakes of salt bearing the stamp of the great Khan were used as money in Tibet. Even today salt takes the place of money in certain parts of the world. When the followers of Mussolini invaded Ethiopia, the native hunters refused to accept Italian currency in exchange for skins. Instead, they were paid in coin-shaped disks of salt. When Addis Ababa was taken by the British in Word War II, they found that the Ethiopian Central Bank was holding its reserve in salt. A later paragraph of this article tells where and when salt has been (and is now being) used as a medium of exchange in the United States.

To early peoples salt represented something imperishable, probably because they had learned it would keep foods from spoiling. It was thus a fitting symbol for an enduring compact. Eastern countries have a time honored custom of placing salt before strangers as a pledge of friendship and good will. Arabian princes ratify an alliance by sprinkling salt upon bread exclaiming, "I am the friend of thy friends, and the enemy of thine enemies." The Greek poet, Archilochus, 2000 years ago said:

> "Thou has broken the solemn oath and
> hast disgraced the salt and the table."

Homer called salt "divine", and Plato named it "a substance dear to the gods".

One of the early written references to salt is found in the Book of Job: "Can nothing which is unsavory be eaten without salt". There are at least 31 other Biblical references to salt, including the well known story of Lot's wife. Faith in the purifying power of salt was indicated by Elisha when he sweetened the waters of Jericho by casting in salt and said: "I have healed these waters." (II Kings 11.) "Ye are the salt of the earth." (Matthew 5:13.)

Belief in the sacred properties of salt persisted through the centuries. In ancient Scotland salt was held in high esteem as a charm, and the salt box was the first chattel to be removed to a new dwelling. In 1789, when Robert Burns was about to occupy a new house at Ellisland, he was escorted on his way by a procession of relatives. In their midst was carried a bowl of salt resting on the family Bible. The spread of the superstitious notion that spilling salt produces evil consequences is probably related to a belief in the sacredness of salt. One who spills it is supposed to incur the displeasure of all good spirits. In his famous painting, The Last Supper, Leonardo da Vinci depicted an overturned saltcellar before Judas. In certain parts of Russia a bride and groom throw salt in the corners of their new home to protect them from evil and to bring happiness and good health. One popular superstition, which is at once the delight and the despair of every little

(Continued on Page 140)

Everybody's Breakfast

• By Andrew Duncan,
MANAGING DIRECTOR, CEREAL INSTITUTE, INCORPORATED, CHICAGO, ILLINOIS

Every morning sixty million Americans eat some kind of prepared breakfast food. But they have little knowledge of the organization and enterprise that makes possible their choice of more than a score of ready to eat, or almost ready to eat, cereals.

This brief story calls attention to a great industry of American origin and development that has affected the eating habits of whole nations.

●

Modern cereal breakfast foods are as American as the Statue of Liberty, but their ancestral roots go back to the stone age. The story of this ancient heritage, from the first wild grains the caveman crushed between his teeth to the more than two dozen varieties of cereal breakfast foods sold today, is a romantic one, weaving as it does through peace and war, tribes and races, and history and legends.

The term "cereal" is derived from Ceres, the name of the ancient goddess of all plant foods—not just of corn as is popularly thought.

About the turn of the twentieth century ingenious Americans invented new machinery and advanced food processing techniques. These were used to produce new food products in many varied versions, making more palatable the cereal grains produced by American farms. This was the birth of the breakfast cereal industry, a typical American enterprise which has vastly extended the consumer use of corn, wheat, oats, barley, and rice grains.

Imagine the amazement and delight of homemakers of a few decades ago when they were first introduced to a variety of convenient, quick-cooking, and ready-to-eat cereals, packaged in sanitary attractive containers and kept ready at hand on their grocer's shelf. No wonder that our spotless cereal mills are famous for having made such an important contribution to American living and eating standards.

Let's have a look behind the scenes at the development of the main dish of today's modern breakfast, a package of cereal breakfast food. The simple pouring of the cereal out of its attractive package can, of course, tell nothing of the research, and of the manufacturing and marketing trials that are necessary in order to bring this beautiful and convenient food to American homes on farms, or in our crowded towns or cities.

Production begins with the raw grains grown by the farmer, but the grains must go through many different processes before they finally appear in a package on the pantry shelf. The first step is from the farm to the grain elevator for storage, handling, cleaning, weighing, and special treatment. They then pass through the commission market into the control of the breakfast cereal manufacturing mills whose modern plants are an outstanding development of American industry, industrial machines highly specialized in all their functions.

Only grains of high quality are used in breakfast cereals. The kernel of corn and the grains of wheat, oats, barley, and rice must undergo several major processes to produce the finished breakfast cereal. The most important are: washing, cooking, drying, flaking, rolling, vitamin enrichment, and, finally, packaging and marketing.

Every cereal breakfast food must conform to these specifications:

1. The products and all the ingredients shall be clean, sound, and wholesome, and shall be prepared, processed, and packaged under modern sanitary conditions.
2. They shall conform in every respect to the provisions of the Federal Food and Drug Act, and regulations promulgated thereunder.

A BATTERY OF BREAKFAST CEREAL TOASTING OVENS.

3. The finished products shall be in fresh prime condition, reasonably free from fine material, and free from rancid, burnt, musty, and other undesirable flavors and odors.

4. They shall be processed with or without flavoring agents, and may contain added dietary factors.

Companies that produce and market breakfast cereals cannot use hit-and-miss methods. Energetic and prolonged research is behind every well-known brand of cereal. Some products have required as many as ten years of intensive research before they reached the consumer. Great research laboratories and spotless test kitchens are maintained in order continually to develop production and to improve quality.

But this research is not confined to the laboratory and the test kitchen. John Q. Public, with critical taste buds, must be consulted. This requires extensive market research. Take for instance the case of the company, back in 1931, which decided to market a certain type of ready-to-eat cereal. The first problem was the selection of the proper type of grain. Extensive market analysis was necessary before a decision could be reached. How to shape the kernels, how to obtain quick service value, and a host of similar problems required hundreds of consumer tests.

After deciding to market it in disc form, further research proved that another shape was more serviceable and more acceptable to consumers. To market the product in the new form it was necessary to design and test special processing equipment and to build an entirely new piece of machinery. There were other production problems. While the mechanical and market researches were being carried on, nutrition scientists were at work testing the product's food value and determining the necessary vitamin enrichment that should go into the product. And still more research was required to design an attractive and sanitary package that would appeal to millions of American consumers.

Many authorities agree that cereals are the economic cornerstone of the menu. They keep down the food bills They are the main breakfast dish for millions of Americans. In a recent nation-wide habit and opinion study it was found that 84 per cent of the people eat cereal, and that 50 per cent of the population eat hot or ready-to-eat cereal four or more times per week. It has been found that an average serving of one ounce of breakfast cereal with a half cup of milk and a teaspoonful of sugar costs only about four cents. The average number of cereal servings to the American people is over sixty million a day. It has been estimated that these sixty million servings save the consumer nearly fifty million dollars annually, in fuel cost alone, over the preparation of other foods.

One noted nutrition authority, Dr. James S. McLester, in his book, *Nutrition and Diet in Health and Disease*, states:

"From an economical standpoint there is good reason for the predominant place occupied by cereal grains; for no other food furnishes an abundance of carbohydrate and protein so cheaply. It has been estimated that the average day's labor of one man on a wheat farm with modern implements produces enough food to meet the requirements of one person for a year."

As one of the "Basic 7" foods, cereals have long been recognized for their important contribution to the nutritional value of the diet. All the cereals (whole grain, restored, and enriched) provide notable amounts of the important B vitamins. In cooperation with the National Nutrition Program, leading cereal manufacturers have made a contribution to better nutrition by restoring processed cereals to the whole-grain values of the essential B vitamins, thiamine, and niacin, and mineral iron. Generally speaking, breakfast cereals are good providers of essential minerals. Cereals are energy producers. They contain an average of about 11 per cent protein.

In the average year, over two and one-half billion quarts of milk are eaten with breakfast cereals alone, involving some 18 billion cereal servings. This represents almost 66 quarts of milk per family per year, or over one quart each week. The breakfast cereal business thus helps increase the demand for milk and other agricultural products. A popular American breakfast dish is fruit served on cereal. This combination which is growing in popularity, has increased the consumption of berries and fruits. Health authorities continually stress the importance of eating a good breakfast. They advise that even the "breakfast skimper" should have at least a basic breakfast of fruit, cereal, milk, and bread and butter, in order to maintain health and well-being.

The story of the breakfast cereal industry is indeed a demonstration of the value of teamwork in which the vast resources of American science and engineering are combined with the energy of American industrial enterprise. Their cooperative efforts have built an industry that does an annual business of more than 200 million dollars, an industry that has made an important contribution by elevating the living and eating standards of people throughout the world. ●

★ ★ ★ ★ ★

"The master teacher radiates his enthusiasm about him in the sparkle of his eye and the vibrance of his voice. He fascinates his students by his general animation, by his engaging manners, by his vigor, by his dress, by his dignity, and by his interest in the subject he teaches."

A. A. POTTER
Purdue University
Association of American Colleges Bulletin

"I Don't Want My Science Pupils to Fail"

• **By Glenn O. Blough, A.M.** *(University of Michigan)*
SPECIALIST FOR SCIENCE, ELEMENTARY DIVISION, U. S. OFFICE OF EDUCATION, WASHINGTON

Things that need saying. Plain talk. Straight from the shoulder. No gloves.

We venture to hope that this hard-hitting article will rile you a bit. Perhaps you need ruffling. We are sure that what is said here will not increase any science teacher's complacency.

This is a challenging article. It can make you a more enthusiastic, a more stimulating, a more successful teacher. We hope it does.

●

"I don't want my science pupils to fail," the science teacher says. And we believe that he means it. That is, the teacher means that he wants his pupils to be able to pass the science examinations with acceptable marks, —to be able to recall the proper words to fit the blanks, to select the proper symbol to show that they know if a statement is true or false, and to write the appropriate answer to such a question as "How is the circulatory system of a frog different from that of a cat?" The science teacher means also that the blanks in the workbook are full of the right words and that the experiments in the notebook are written up with care and in detail. That at least is what countless numbers of science teachers mean when they discuss the success and failure of their pupils.

But the science teacher should wish for much more than this if he really hopes that his pupils will not fail. Suppose a science pupil passes his examinations with flying colors and graduates, but fails all the remainder of his life to be aware of the wonders of science, to think carefully and accurately, to be a worthy citizen, to make friends, to stand for fair play, to understand the meaning of democracy and to assume his responsibility as a member of one? Then what? Has he failed his science?

Suppose he's in the upper quarter of his science class but later turns out to be superstitious, a fuzzy thinker, a maladjusted member of society, a dullard, an intolerant narrow-minded citizen unable or unwilling or incapable of making a wise decision in any matter of importance. Has the science teacher failed?

We who are interested in science teaching should give serious attention to what we believe constitutes success or failure in science teaching. What exactly do we hope for? Are our aims broad enough? Are our science courses designed and taught so that they will contribute their fair share, along with the other areas of learning, toward producing well-rounded individuals equipped to take their place in a democratic world? Observation of classes over a big chunk of America indicates that too few are. The big push seems to be to teach 'em the facts. Pupils are expected to learn tolerance, problem solving, cooperation, democratic procedures, resourcefulness, critical mindedness, and the other attributes of a good citizen through living in the same room an hour a day with physics apparatus, following the directions for performing an experiment and filling in workbook blanks. It is neither probable nor possible that they will. If science teachers are really concerned about turning out well-rounded products, then they must begin to give more and more attention to *how* science is being taught.

But the foregoing means more if we illustrate it by an example. Last year, a high school class in physics composed of 25 pupils studied sound. The physics teacher introduced the study by making a page assignment to be read "and be prepared to discuss it tomorrow." Tomorrow came, and the introductory discussion which was supposed to fire pupils with enthusiasm for the study of sound was pretty drab. Sentences like the following had discouraged and bewildered the pupils: "A note whose vibration rate is a whole number multiple of that of the fundamental is called an overtone, or harmonic." The physics teacher brought from his apparatus closet a sonometer to use in the study of the laws of strings. He demonstrated with the instrument for the class but since there was little readiness and background, and less interest, very little learning took place. The whole procedure for the study of sound was academic. The teacher seemed very skilful at two things: 1, making a relatively simple idea seem difficult because of unnecessary scientific vocabulary and, 2, making scientific ideas that are actually near at hand, appear to be at least a million miles away. The physics classes in this school are always small and unpopular.

How can this science teacher improve his approach so that he will accomplish broader aims and provoke greater enthusiasm from his pupils?

First, this physics teacher knows very little about his pupils. He could be a smarter teacher if he knew that several of them live an hour and a half from the school and consequently put in a very long day. One has serious eye trouble. One is an orphan who lives with an aged grandmother. Several have trouble in reading. One wants to be a scientist but has not decided yet what branch of science he's interested in. Two of the girls come from wealthy homes and are being forced to take college preparatory courses against their will. Two or three pupils have serious trouble in mathematics. One is from a broken home, his mother is on welfare. The physics teacher is not only unaware of things

(Continued on Page 144)

Homemade Biology Models

• By Patricia Doherty

SENIOR STUDENT, DEPARTMENT OF BIOLOGY, CALDWELL COLLEGE, CALDWELL, NEW JERSEY

This how-to-do-it article was written by a senior biology major after she had constructed for high school use the models shown in the illustration. Her work was directed by Sister M. Joanna, O.P.

Her procedures will interest others who have the time and the inclination to make similar teaching aids.

●

Making models is fun; it is hard work too, but their making pays dividends both in subject knowledge gained and in the joy of creation. If they are used in the laboratory in connection with the experiment at hand, they are instructive and enlightening since unlike the picture and the microscope image they are three-dimensional. The cost is negligible. Asbestos is cheap, and every laboratory has pieces of dried glue. The stands used for these models are those on which geological specimens are displayed. The only purchases necessary are the mold and the cement glue.

Assemble the materials. You will need powered asbestos, dried glue, a plastic hamburger mold or other suitable mold, a little glycerine, twill tape, thread, wool, water-color paints, household cement glue, and the mounting blocks.

In making our models illustrating the phases of plant mitosis, all sizes and shapes of molding instruments were tried. Asbestos is difficult to cut with a cookie cutter or other sharp instrument, since the edges fuzz because of the fiber content. A square mold is preferred because a circle is so symmetrical that it is difficult to get it perfect. If necessary, the corners of a square can be cut off to balance it correctly. A hamburger mold purchased at the five-and-ten answers the purpose admirably.

The first step is to mix about fifteen tablespoonfuls of asbestos with enough glue water, made by pouring hot water over dried pieces of glue, to make a dough. After the mold is rubbed with glycerine, the dough is put in and leveled off. The asbestos is immediately dropped out of the mold gently onto a piece of waxed paper. Several days will be required for it to dry thoroughly. To cover up the uneven sides, put twill tape around the sides and top and fasten it with glue or with a small straight pin on the lower part of each side.

The nucleus is constructed of the asbestos dough and molded with the fingers. The shapes of the changing

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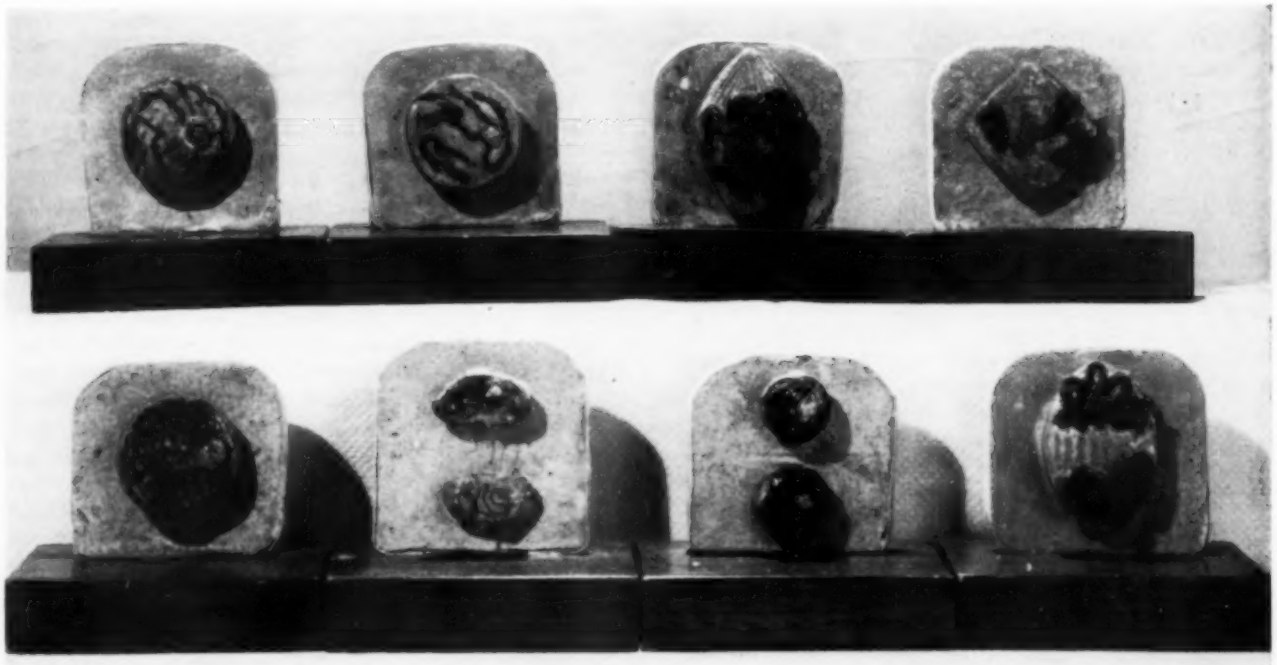

HOMEMADE MODELS USED TO ILLUSTRATE PLANT MITOSIS.

Radar and its Uses

• **By Jack M. Clark**

CAPTAIN, UNITED STATES AIR FORCE RESERVE, HEADQUARTERS, NEW YORK PORT OF EMBARKATION, BROOKLYN, N. Y.

This paper will teach you more about Radar than you ever knew before.

It is an account of one of the secret wonder weapons of World War II.

It won victories, sank ships, saved American lives, and destroyed enemy lives. It has many new peacetime uses.

Captain Clark, who is well informed about radar, writes about it in a plain clear style that makes the difficult seem simple.

The United States Army Signal Corps supplied the illustrations for this article.

●

In spite of all the secrecy that has surrounded the subject of Radar until recently, a radar set actually is nothing more nor less than a "souped up" radio set—a new application of radio. In fact, the word "Radar" is derived from "*Ra*dio *D*etection *a*nd *R*anging." It is a process for detecting the presence of distant objects and determining their distance by the use of radio waves. It can also be used to determine the direction of the object from the radar set, its elevation, and in the case of a moving object, its speed and direction of travel.

First, (Figure 1) let us look at the relationship between Radio, Television and Radar. Here are three separate diagrams. The upper one is a rough block diagram of an ordinary radio broadcasting transmitter and the radio set in your own home. Sound waves picked up by the microphone are converted into electrical signals and broadcast in all directions by means of the transmitter and antenna in the form of electrical waves of energy. A small amount of this energy is picked up by the antenna of the radio receiver, amplified and detected by the receiver, and converted back to a reproduction of the original sound waves by the radio loud-speaker.

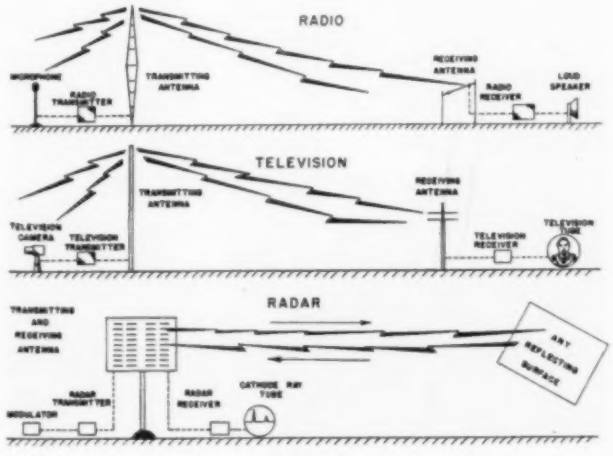

FIGURE 1.

The second block diagram represents a television transmitter and receiver. Here we find the microphone replaced by a television camera which converts not sound waves, but light waves,—a picture—into electrical waves. These are then broadcast in all directions to be picked up by the antenna of the television receiver, amplified in the receiver, and converted by the television tube to a reproduction of the original picture. Actually, in the ordinary television set you have a combination of radio and television, so that both sound and picture are transmitted and reproduced.

The third block diagram represents a typical radar set. We still have a transmitter and a receiver, but now with the important basic difference that they are both at the same location. Also ordinarily, although not necessarily, both the receiver and transmitter use the same antenna, which is usually much more elaborate than a radio or television antenna. Instead of a microphone or television camera to control the operation of the transmitter, we have a "Modulator," whose function is to turn the transmitter on for very short pulses of from one-quarter of a millionth to a few millionths of a second followed by an off period of a few thousandths of a second. Instead of radiating in all directions, these very short pulses of extremely high power are sent out by the antenna in a concentrated beam at a speed of 186,000 miles per second. If these waves meet no obstructions, they continue on and are lost for all practical uses.

However, should the radio beam strike an object, such as a building, an airplane, a ship, a hill, etc., some of the energy is reflected. A very small part of it will be reflected in a straight line back to the radar antenna, which picks it up again and delivers it to the receiver where it is amplified many times and appears on the cathode ray tube as a spot of light. The cathode ray tube is similar to the television tube. There will be a separate spot on the tube for each object. Since the speed of the radio beam is constant, going out and coming back, the distance from the point on the tube which represents the position of the radar, i. e., the start of the pulse, to the point where the "echo" shows,

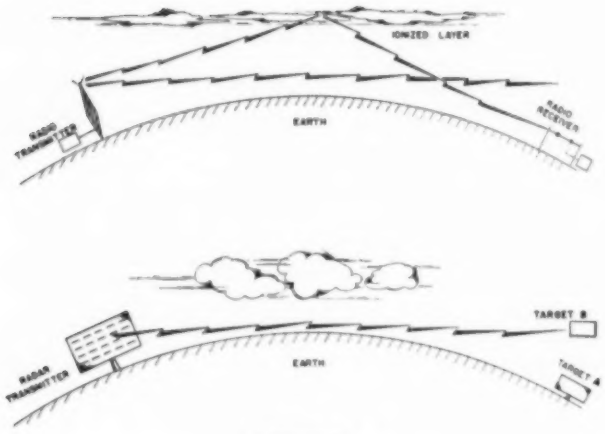

FIGURE 3.

is in proportion to the object's distance. Figure 2 shows how a typical radar "sees" surrounding objects. The center of the picture corresponds to the position of the radar, in this case on a ship proceeding up the Hudson River at New York City.

The larger an object is, the more it will reflect, and the larger the spot of light on the scope. Metallic objects such as planes and ships reflect better than buildings, land and water. Skilful operators can usually distinguish between bombers and fighters, and between one plane or more.

These are the basic principles of radar. As you can see, they are not too much different from ordinary radio transmission. It is in attemping to apply these principles to actual use that complications are encountered. There are several reasons for this, one being that the relatively low frequency waves used in radio are not sufficiently reflected by relatively small objects, such as aircraft and ships, to give a reflected "echo" which can be picked up. Therefore, radar frequencies are commonly up to 50,000 or more times greater than ordinary broadcast radio frequencies. In fact, infrared light rays are only a few thousand times greater than some radar frequencies. Immense new problems are immediately presented in designing equipment to operate at these high frequencies.

The high frequencies that are required in radar die out much faster as they travel, so that to reach a given distance much more power is required than with radio. Couple with this the facts that the radar waves must travel twice as far—out and back,—and that the loss in traveling this double distance is not proportional to the distance traveled but to the square of the distance traveled, and it becomes apparent what terriffic power must be transmitted to get even a weak return signal. However, the radar transmitter only transmits a very short pulse at a time. We are thus required to build an instrument that can transmit an extremely high power output but for only a very short instant at a time. This saving feature greatly reduces the average power output requirement of the transmitter, but the problem is still immense and new and revolutionary transmitting tubes had to be designed. A radar set's peak power output may be four million watts, as much as 80 to 200 times the peak power output of the ordinary radio broadcast transmitter.

Another problem is illustrated by Figure 3, an exaggerated drawing showing the curvature of the earth. Remember that radio waves normally travel only in straight lines, except for some curvature along the surface of the earth at lower frequencies. The radio transmitter sends out energy in all directions. In Figure 3, the direct beam which is shown going out from the radio transmitter goes right on by, and is not picked up by the receiver. However, there are other waves which strike the ionized layer, an electrified layer of atmosphere, and are reflected to the radio receiver. It is this reflection phenomenon which makes it possible to receive broadcasts from a station several hundred miles away. Unfortunately, the high frequency waves of radar are not sufficiently reflected in this manner by the ionized layer. Thus, with radar transmission we use only the direct beam. An object in the position of "Target A" would not be in the path of this beam and would not be detected by the radar. If the target were at position "B", however, it would be detected. A radar set, in general, can only "see" as far as the horizon. For this reason combat airplanes in battle often fly very low, or "hedge hop" to get under radar beams, in this way avoiding detection until very close. If an airplane is to be detected at a distance of 200 miles, it must be at an altitude of approximately 30,000 feet.

(Continued on Page 139)

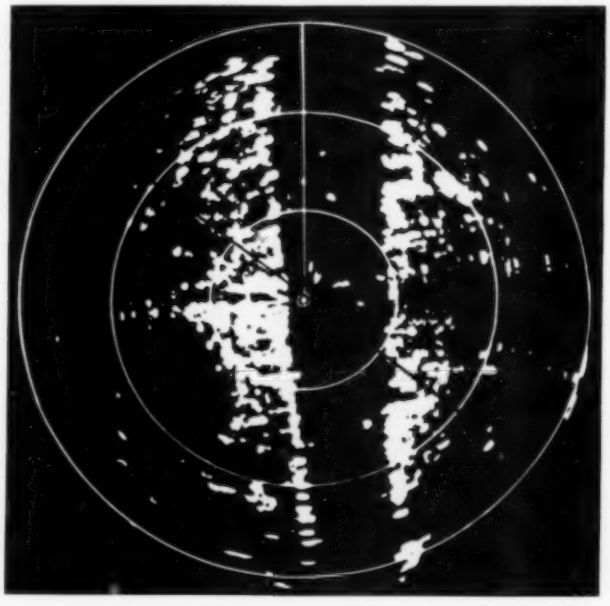

FIGURE 2.

Readability of General Chemistry Textbooks

A Preliminary Study

• **By Sister M. Ignatia, I.H.M., M.S.** *(Catholic University)*
and Margaret Doyle, SENIOR STUDENT,
DEPARTMENT OF CHEMISTRY, MARYGROVE COLLEGE, DETROIT, MICHIGAN

How readable are our science textbooks? Do teachers pay enough attention to this factor when they select textbooks, or authors when they write them? Is there a scientific approach to the determination of readability? How can readability be improved? Is it always desirable? Should all difficult passages be eliminated?

This preliminary and very brief study of a few short passages from a dozen college textbooks is, of course, inconclusive, but it points a way. It will interest teachers, authors, and publishers.

How do the textbooks you use rate? What about the texts you write?

●

Readability is a term frequently used by librarians and teachers of education, but seldom by chemistry teachers or reviewers of scientific books. Yet, since we all read and choose or recommend reading material for others, should we not be concerned with the idea expressed by that term?

How readable are the numerous general chemistry textbooks now available? How readable should they be? Are there significant differences as we go from book to book, or from topic to topic in the same book? These are but a few of the problems that could be investigated if we had a reliable, objective tool for the quantitative determination of "readability."

In 1943, Dr. Rudolf Flesch of Teachers College, Columbia University, proposed a formula which may be such a tool. This formula, presented in the book, *Marks of Readable Style*, is the result of a series of experiments originating in the Readability Laboratory of the American Association for Adult Education. Early in the book, Dr. Flesch describes readability in three terms: lucidity, comprehensibility, and appeal, "indicating that a popular writer's three main duties are to think clearly, to write clearly, and to be interesting.[1] Even though Dr. Flesch is concerned with adult education and the production of readable books for individual, undirected study, we can profitably examine textbooks as to clarity of thought and expression, and appeal as well.

Dr. Flesch's formula is based on the theory that "simple, easily understandable English can be achieved by using short sentences, few affixed morphemes, and many references to people."[2] He defines morphemes as do the linguists, as the "relational elements in the language",[3] — the affixes. According to the *Oxford Dictionary*, an affix is "an addition placed at the beginning or end of a root, stem, or word, to modify its meaning," e.g., infra- in the word infrared, and -ol in phenol. Since there are three qualifications in his theory of readable English, Dr. Flesch includes in his formula three variable factors: a sentence factor, X_S; a morpheme factor, X_M, and a human interest factor, X_H.

X_S — the average number of words to a sentence.

X_M — the number of affixes in a one hundred word sample.

X_H — the number of personal references per one hundred words.

These three variable factors are weighted by means of constants in the formula by which we calculate the reading grade placement, X.[4]

$$X = 0.1338\ X_S + 0.0645\ X_M - 0.0659\ X_H + 4.2498$$

Note that the difficulty of a passage increases with an increase in either the sentence length or the number of affixes, but is lowered by personal references. The weights accorded to X_M and X_H are about equal, while X_S has a weight more than twice that of either of the other two. Note, too, that since this formula was devised for the grading of adult reading, mere memory for isolated word meanings is not included as a factor.

A reading grade placement of 5.9 or below is considered very easy reading and one of 11.0 or above, very difficult reading. The gradations in difficulty at the upper end of the scale may be listed in tabular form.[5]

TABLE I
Gradations in Readability

Reading grade placement	Description	Level
11.0 and above	Very difficult	Post-college
10.0 to 10.9	Difficult	College
9.0 to 9.9	Fairly difficult	Senior high school

In our preliminary application of the Flesch formula to general chemistry textbooks, we selected twelve books, representative of those used in American colleges and universities. From each of the books we took three one hundred word samples,—one on the meaning of *mole*, one on the kinetic theory of gases, and one on Le Chatelier's principle. For an exhaustive study, many more samples would have to be taken, but since this is a preliminary study, we considered three from each book to be sufficient. The reading placements obtained, however, indicate the difficulty of these samples, rather than the difficulty of the books as a whole.

TABLE II

Books According to Sample Mean Difficulty

Author	Title	Edition	Publisher	Date	Mean placement
Brinkley	Introductory General Chemistry	3rd	Macmillan	1945	11.00369
Schlesinger	General Chemistry	3rd	Longmans, Green	1938	10.46911
Hildebrand	Principles of Chemistry		Macmillan	1937	10.42396
Timm	General Chemistry	1st	McGraw-Hill	1944	10.34951
Deming	General Chemistry	5th	John Wiley & Son	1944	10.32734
Kendall	Smith's Introductory College Chemistry	Rev.	D. Appleton Century	1938	10.31628
Babor and Lehrman	Introductory College Chemistry		Thomas Y. Crowell	1941	10.10073
Briscoe	College Chemistry		Houghton Mifflin	1945	10.06208
Pauling	General Chemistry		W. H. Freeman	1947	9.98475
Richardson, Scarlett	General College Chemistry		Henry Holt	1940	9.88205
Holmes	Introductory College Chemistry	4th	Macmillan	1946	9.71035
Young and Porter	General Chemistry, A First Course	Rev.	Prentice-Hall	1946	9.34442

In selecting the samples we tried to pick out similar passages. From the third edition of Brinkley's *Introductory General Chemistry* we took the following sample on the mole:

> . . . Consequently, it is desirable to convert atomic and molecular weights to the ordinary units of weight, while still retaining their significance as relative weights. This may be accomplished by multiplying atomic and molecular weights by one gram, since the validity of a ratio is not altered by multiplying both members by the same term. *The weight in grams which is numerically equal to the atomic weight of an element is one gram atom, and the weight in grams numerically equal to the molecular weight of a substance is one gram molecule or one mole.* The atomic weight of oxygen is 16 and one gram atom is 16 g. One mole of water is 18.016 g. and one mole of carbon dioxide is 44 g.[6]

From the fifth edition of Deming's *General Chemistry* we selected:

> **Moles and Molal Volumes.** A *gram molecule* or *mole* of any substance is as many grams of it as there are units in its molecular weight. A mole of oxygen, O_2, is 32 g.; a mole of carbon dioxide, CO_2, is 44 g.; and so forth. (We find the sum of the weights of all the atoms in the molecule and express the result in *grams.*)
>
> Since a mole is a weight that is large or small in proportion to the molecular weight, it represents a definite, very large number of molecules, *the same for all substances.* So, if we are asked to weigh out equal numbers of molecules of a number of different substances, we simply weigh out equal numbers of moles.[7]

Which of the two selections is the more readable? In Brinkley's paragraph the average sentence length is 24.6 words, while in Deming's it is only 19.8. In one hundred words Brinkley has 65 affixes and Deming only 30. Deming has two personal references (the word *we* occurs twice) while Brinkley has none. Consequently, for this selection from Brinkley,

$$X = 3.29148 + 4.1925 - 0 + 4.2498 = 11.73378;$$

and for the paragraph from Deming,

$$X = 2.64294 + 1.935 - 0.1318 + 4.2498 = 8.70224$$

Hence, the formula classifies the first quotation as very difficult, and the second as only fairly so.

Since this study of readability was made by a member of the class in modern statistics, we applied R. A. Fisher's method of analysis of variance and G. W. Snedecor's F test to the data to determine whether or

TABLE III

Readability of Samples According to Authors and Topics

Author	Topic placement			Total	Mean
	Mole	Kinetic theory	Le Chatelier's principle		
Brinkley	11.73378	10.77864	10.49866	33.01108	11.00369
Schlesinger	10.31136	10.68857	10.40740	31.40733	10.46911
Hildebrand	9.08303	11.31195	10.87691	31.27189	10.42396
Timm	9.87424	10.95080	10.22348	31.04852	10.34951
Deming	8.70224	11.14230	11.13748	30.98202	10.32734
Kendall	10.32914	10.83696	9.78275	30.94885	10.31628
Babor and Lehrman	9.59227	10.52695	10.18296	30.30218	10.10073
Briscoe	9.52995	9.73385	10.92245	30.18625	10.06208
Pauling	10.16945	9.62722	10.15758	29.95425	9.98475
Richardson, Scarlett	8.93390	10.72852	9.98372	29.64614	9.88205
Holmes	9.51007	9.67870	9.94227	29.13104	9.71035
Young and Porter	8.38953	9.59407	10.04966	28.03326	9.34442
Total	116.15896	125.59853	124.16532	365.92281	
Mean	9.67991	10.46654	10.34711		10.16452

not the differences in readability among books is significant.

TABLE IV

Analysis of Variance

	Sums of squares of deviations	Degrees of freedom	Mean square deviation
Books	5.86070	11	0.53279
Topics	4.31281	2	2.15640
Error	9.47736	22	0.43079
Total	19.65087	35	

According to the *F* test (and R. A. Fisher's z test leads to the same conclusion), the differences among books are not significant.

$$F = \frac{0.53279}{0.43079} = 1.23677$$

and when $n_1 = 11$ and $n_2 = 22$, $F = 2.26$ at the 5% level, and $F = 3.18$ at the 1% level.

To be significant, F would have to exceed 2.26, and to be highly significant, F would have to exceed 3.18. Our value of F is only 1.24 and could easily be due to chance alone.

The differences among topics, however, are shown by the *F* test to be significant, but not highly so.

$$F = \frac{2.15640}{0.43079} = 5.00569$$

and when $n_1 = 2$ and $n_2 = 22$, $F = 3.44$ at the 5% level, and $F = 5.72$ at the 1% level.

Our value of F is close to the 1% level and is probably not due to chance alone.

This significant difference among topics is surprising, since the samples chosen were all from theoretical material, rather than samples selected at random. For most of the books, the selection on the meaning of the word *mole* was the most readable of the three, and since students read that part of the textbook shortly after they enter college, it is well that it should be the least difficult. The other two averages for topics fall in the lower half of the college interval, which is undoubtedly the place where they should fall.

For the books, two-thirds of the placement averages fall in the lower half of the college level, and one-fourth in the senior high school level. It is interesting to note that according to the Flesch formula the samples taken from Pauling's new book are quite readable and Young and Porter's text has the lowest average placement.

Different instructors will prefer different levels of readability in the textbooks they adopt, and even the same instructor may prefer different levels for different groups of students. In order to increase their powers of reading, all students should read passages that are hard but not impossible for them. Whether the instructor wants them to do this continually or only occasionally, is a matter of personal choice. After all, readability is only one point to be considered in choosing or recommending a textbook, and as Norris W. Rakestraw expressed it in his recent review of Pauling's new book, "With so many now in the field, a textbook of general chemistry, to be outstanding, must be more than comprehensive, interesting, well written, and merely up to date."(8) ●

REFERENCES

1. Flesch, Rudolf. *Marks of Readable Style.* New York: Teachers College, Columbia University, 1943, p. 3.
2. *Ibid.*, p. 37.
3. *Ibid.*, p. 22.
4. *Ibid.*, p. 64.
5. *Ibid.*
6. Brinkley, Stuart R. *Introductory General Chemistry,* Third Edition. New York: Macmillan, 1945, p. 23.
7. Deming, Horace G. *General Chemistry,* Fifth Edition. New York: John Wiley & Sons, 1944, pp. 82-83.
8. *Journal of Chemical Education.* 25 (April, 1948), 237.

★ ★ ★ ★ ★

Etching Replaces Customary Medal In the Fisher Award

Dr. N. Howell Furman of Princeton University was the first recipient of the annual A.C.S. Fisher Award at the Fall Meeting of the American Chemical Society.

The symbol honoring Dr. Furman's achievements in analytical chemistry is an etching which was made and appropriately inscribed especially for the purpose. Dr. Furman also received a prize of $1,000.00.

The selection of an original etching instead of the usual medal to symbolize this Award evolved from consideration of the question—"What does one do with a medal?". The picture which Dr. Furman received is one that any modest man would be pleased to hang in his office.

Chester G. Fisher, President of Fisher Scientific Company and Eimer & Amend, and donor of the A.C.S. Fisher Award, commissioned Theodore Brenson, well known modern artist, to make the original etching which depicts an alchemical laboratory.

Theodore Brenson was born in Riga, Latvia. His work is on exhibit in many American and European art centers, including the United States Library of Congress and the Metropolitan Museum of Art. ●

★ ★ ★ ★ ★

Carleton Appointed

Robert H. Carleton, newly appointed executive secretary of the National Science Teachers Association, assumed office and field duties on September 1 with headquarters at 1201 Sixteenth Street, N.W., Washington, D. C. He left his position as assistant professor of physical science, Michigan State College, East Lansing, to accept the appointment.

Mr. Carleton has degrees from Ohio State University and New York University. He is a member of Phi Beta Kappa and Phi Delta Kappa. A contributor to science teachers' magazines and reports in science education, he is also the author, singly and with others, of ten science textbooks.

In the new office, Mr. Carleton will be responsible for many promotional and service activities of the National Science Teachers Association directed toward aiding science teachers at all educational levels.

Middle America: Agricultural Experiment Station for New Crops

• By Marion Mann
DIRECTOR, MIDDLE AMERICA INFORMATION BUREAU, NEW YORK, N. Y.

This article points out that Middle America is fast becoming an important commercial source of hemp and African palm oil. It may eventually supply us with natural rubber, quinine, derris, and certain tropical spices, fruits and subsistence crops.

The agricultural development of new crops in this region is one of the farsighted policies of the United Fruit Company. You will be interested to learn what encouraging progress has been made.

●

The countries from Mexico on the north to Colombia on the south, together with the island states of Cuba, Haiti and the Dominican Republic, make up what is known as Middle America. Scattered throughout this tropical region are 4,700 square miles of property, mostly reclaimed jungle, operated by the United Fruit Company. No more than 226 square miles of these holdings are devoted to banana plantations.

The fact is that although half of the eight billion bananas the citizens of the United States consume annually are grown and imported by the United Fruit Company, the Company's activities are far from being confined to producing, harvesting and marketing the golden, tropical fruit. Its holdings in Middle America include some 100,000 acres planted to sugar-cane, and nearly 50,000 more to cacao, better known north of the Rio Grande as cocoa. In addition, new crops such as abaca and African palm oil, introduced during World War II, are raised in impressive quantities. The story of the development of these crops is of importance to every American.

For a century American shipping and industry depended on the Philippines and, to a lesser degree, the Dutch East Indies, for Manila hemp, from which the majority of cordage products were made. Pearl Harbor cut off the source of supply completely. Fortunately, in 1925 the United Fruit Company, in conjunction with the United States Department of Agriculture had brought abaca (the banana-like plant from which Manila hemp is produced) to Panama for experimentation. Originally only a ten-acre plot was given over to it, but by 1940, 2,000 acres had been planted.

No profit was accepted on the abaca raised while the war was on. The fibre was turned over to the government at cost. Before the end of the war, Panama, Costa Rica, Guatemala and Honduras among them were producing dry abaca fibre at the rate of a million pounds a week. Today United Fruit's cultivated lands include 26,000 acres of this important fibre plant.

Since the 1880's, the United States has imported palm oil by the millions of gallons yearly, most of it from Oceania and tropical Africa. African palms were transplanted to Honduras and Costa Rica in 1944, and already the Company has 14,000 acres of palm groves. Palm oil is considered to be every bit the equal of coconut oil—which is used in vast quantities by industrial and chemical plants—and is, as well, edible both by humans and livestock.

The cinchona, or "fever tree," which produces quinine, is native to Middle America. Yet practically all of the world's quinine was furnished by Java and Sumatra up to the time of Pearl Harbor. It has been estimated that more than 1,500,000 cinchona trees are growing wild in the jungles of Guatemala alone. Commercial cultivation of the trees was begun during the war years, and the time may not be too far off when Middle American quinine will hold the place formerly occupied by the East Indies product.

Rubber was another Far Eastern monopoly of which we were deprived at the outbreak of the war, and the enormous growth of the synthetic rubber industry since is one more example of necessity's being the mother of invention. But natural rubber is still in demand, and with little more development than at present, Middle America could supply 100,000 tons a year. Among other Far Eastern products whose cultivation was begun in Middle America as a result of the war were teak and bamboo, both of which thrived in experimental growths in the tropics of the Western Hemisphere.

A powerful insecticide extracted from the roots of the derris and similar plants, rotenone, was furnished the Government in million-pound quantities during the war years. Great expansion of Middle American derris growing is entirely possible, and probably will take place since the new insecticide is becoming indispensable to farmers in combating crop pests.

The war, in fact, transformed Middle America into one of the world's great food laboratories. In experimental plantings along the 2,000-mile stretch from Honduras to Colombia, it has been conclusively demonstrated that many raw materials hitherto associated with the African and Pacific and Far Eastern tropics can be successfully grown in the lands to the immediate south of us. Spices, fruits, subsistence crops—among them the soybean—were introduced.

But modern agricultural knowledge had to be inculcated among Middle American farmers if the new

(Continued on Page 152)

for DECEMBER, 1948

NEW BOOKS

Sunspots in Action

• *By* HARLAN TRUE STETSON. New York: Ronald Press Co. 1947. Pp. IX + 252. $3.50.

There is not a dull page in this book. It will inform, stimulate, and entertain the scientist as well as the novice. It is easy reading.

It was written by a brilliant scientist who has the rare ability to write in layman's language about the scientific phenomena whose study has been his lifework. Teachers of science should read this book for special knowledge as well as for background information. It may open new vistas.

Dr. Stetson's discussion of atomic energy and the sun, the electrical state of the earth's atmosphere, and the utilization of solar energy leads into a study of the nature and origin of sunspots, the terrestrial consequences of sunspot activity, and how such activity may be predicted. He shows its relation to radio reception, to weather and long range weather prediction, to the beautiful Northern Lights, and to certain periodicities that at first seem to have no relation to solar phenomena.

Did you know that over the centuries there is a striking agreement between sunspot cycles and the growth pattern of trees? Can sunspots influence aviation? Were they considered in war planning? Have they any effect on economic cycles, bringing booms and depressions in regular sequence? Read this book to find out.

H.C.M.

Essentials of College Chemistry

• *By* G. H. WHITEFORD and R. G. COFFIN. 3rd Edition. St. Louis: C. V. Mosby Co., 1948. Pp. 632. $4.75.

In this second revision of a well-known text the authors have attempted to maintain their original purpose of holding to the fundamentals of the science, while still presenting adequate illustrations of chemical principles and descriptions of typical chemical processes. A chapter on electrochemistry and its applications has been added; also one on hydrocarbon derivatives and other important organic compounds.

This volume is an adequate presentation of the subject matter in the traditional general chemistry course. While it is true that many portions of the text have been rewritten and essential new material added in an attempt to obtain conformity with modern theory and practice, it appears that not all these attempts have been completely successful. The general viewpoint is still that of the 1920's; more recent developments appear as a veneer, with the earlier viewpoint showing through in places. The result of such attempts at "modernization," in this and other books, is a dual presentation (and in this case a not-too-well integrated one) of such topics as ionization, acids and bases, and structural chemistry in general.

Deviations from strict accuracy are necessary in an elementary treatment to preserve a reasonable simplicity of presentation. In this book there are, however, in the opinion of the reviewer, some unnecessary deviations and some misleading simplifications. To cite a few examples at random:

p. 197. "Oxygen does not form compounds with fluorine." Actually, OF_2 has been known for quite a few years.

p. 59. The impression that the increase in the number of collisions of the molecules of a compressed gas *causes* the rise in temperature may be difficult to eliminate later on when a more nearly correct discussion is necessary.

p. 214. It is questionable whether formulas for nonexistent compounds (e.g., $AlPO_3$) should be given, even if intended only to illustrate formula writing.

p. 233. "—the concentration of non-ionized water is enormous (nearly unity)—." Actually, it is 55.51 moles per liter.

The authors do deserve commendation, however, for introducing information on new industrial processes and new uses of old materials. In no other textbook has the reviewer yet seen, for example, the electrolytic preparation of sodium carbonate, the Bucher process for fixing nitrogen, or the use of cobalt as a binder in making high-speed cutting tools.

Also to be commended are the extensive (and readable) references and exercises, the excellent typography and appearance, and the freedom from typographical errors.

T. H. D.

Personal and Community Health

• *By* C. E. TURNER, 8th edition. St. Louis, Mo.: C. V. Mosby Co. 1948. Pp. 565. $4.00.

This 8th edition of a text on personal hygiene and public health is intended for the student with a limited science background. Supplementary reference to the basic sciences (anatomy, physiology, bacteriology, and chemistry) is made in order to clarify portions of the text. This volume is intended for the general or survey course rather than for an intensive course in public health. The book is written in a clear, interesting, easy to read style and adequately covers the subject.

Alfred Halpern

Science in General Education

• *Edited by* EARL J. MCGRATH. Dubuque, Iowa. Wm. C. Brown Co. 1948. Pp. VIII + 400. Paper bound. $3.25.

A good many educators are convinced that most current college programs are too narrow and specialized to prepare graduates adequately for living in a modern age. In an endeavor to improve the situation a number of schools have instituted programs of general studies for all students. The programs always contain some kind of instruction in science for non-science students. The report under review describes a number of such courses, their content, mode of operation, and the philosophy on which they are based. It is a series of statements or progress reports by representatives of schools that have instituted such courses in the physical and biological sciences and are making a contribution toward solving the problem of inadequate general education. Large and small, publicly supported and privately conducted universities and colleges, are included in the report.

The science survey courses instituted after World War I have lost favor because of their attempted broad coverage and resulting superficiality. The new plan is to study in a serious way a few problems selected with discrimination, preferably those dealing with basic natural laws and phenomena in which more than one science is concerned. Students are taught the meaning of science, its significance in modern life, and its essential unitary nature. Fresh points of view, new modes of attack, broadly trained and interested instructors are essential. There is a dearth of suitable textbooks, of qualified instructors, and of suitable means for evaluating the results of instruction, but encouraging progress is reported by the schools represented in this publication.

The report is edited by Dr. Earl J. McGrath, dean of the college of liberal arts, State University of Iowa, who has visited hundreds of colleges and universities to study their programs in general education.

H.C.M.

Essentials of Radio

• *By* MORRIS SLURSBURG and WILLIAM OSTERHELD. New York: McGraw-Hill Book Company. 1948. Pp. XII + 806. $4.00.

Messrs. Slursburg and Osterheld, who teach in secondary schools, have written an excellent basic text on the high school—vocational school—junior college level for persons interested in radio and electronics. It can be used for home study without an instructor. In spite of the technical nature of the material the book is relatively easy reading. A minimum of mathematics is employed. There are numerous diagrams and photographic illustrations, many questions and problems, and a comprehensive bibliography. Abbreviations and symbols are in accord with accepted standards. The 18 appendixes give a wealth of pertinent information. This book will provide a good foundation for further study in the field of electronics and high frequency.

A. K.

Materia Medica and Pharmacology

• *By* ELSIE E. KRUG and HUGH A. MCGUIGAN. 5th Edition. St. Louis, Mo.: C. V. Mosby Co., 1948. Pp. 558. $4.00.

This text, written from the point of view of the student nurse, has many features not included in other texts designed to serve the same purpose. In addition to a thorough discussion of the pharmacodynamics of drugs, information concerning the technique of administration, the history of pharmacology and the legislation applicable to the administration of drugs, is included. The present 5th edition has been brought up to date with the latest editions of the *United States Pharmacopoeia* and the *National Formulary*. In addition to the "official" drugs many therapeutic agents approved by the Council on Pharmacy and Chemistry of the American Medical Association are included.

A suggestion might be made that the older term "materia medica" be deleted from the title, and "Theory and Practice of Pharmacology" or a similar title be substituted.

Alfred Halpern

Chemistry in Action

• *By* GEORGE M. RAWLINS and ALDEN H. STRUBLE. Boston. D. C. Heath and Co. 1948. Pp. VI + 568. $3.00.

In a simply worded preface directed to the pupil (as it should be) rather than to the teacher, the authors of this high school chemistry state their two chief aims: (1) to help the pupils understand and appreciate the role of chemistry in their daily lives, and (2) to teach students to reason scientifically.

To the reviewer it appears that by the proper use of this book the objectives should be achieved. Classroom use by many teachers, good, bad, and indifferent, will be the real test, but a careful examination of the text shows a number of features that appeal. First is the fact that the book is commendably brief and at the same time reasonably comprehensive. It was written by men experienced in teaching at the high school level. There are 9 units composed of 46 problems. Their sequence follows the plan developed and tested in the District of Columbia public schools. Chemical principles rather than chemical facts are emphasized. The three units on the chemical view of matter, the structure of matter, and the theory of solutions fill 164 of the book's 527 pages. Problem solving has not been neglected. The usual teaching helps are provided. A double column 6½″ × 9¼″ page, good type selection, and unusually fine illustrations make the book attractive in appearance.

H.C.M.

★ ★ ★ ★ ★

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Radar

(Continued from Page 132)

Transmission problems are also greatly increased at high frequencies. A pair of wires no longer will work, due to the extremely high losses which result; also, materials which are good insulators at low frequencies break down or become conductors at high frequencies. An entirely new approach to transmission of radio waves was developed. The result of experimentation and research in this field is "waveguides." Waveguides look like round, square, or rectangular pipes. In fact, the slang expression for waveguides is "plumbing". The single hollow conductor or waveguide guides radio waves much as an ordinary pipe carries water. The higher the frequency to be transmitted, the smaller the waveguide used.

The ordinary radio transmitting antenna radiates energy in all directions. The radar antenna must concentrate all this energy into a narrow beam. A great deal of time and research has been expended in the design of radar antennas. The antenna is usually the most distinctive feature of the set and gives a good indication of the use to which the set is to be put. The most common type in use is a parabolic of modified parabolic antenna. These focus the radar beam much as parabolic mirrors focus beams of light.

Between 1922, when Dr. Albert H. Taylor, working for the United States Naval Research Laboratory, noticed that short wave signals being transmitted across the Potomac River were reflected back by passing ships, and the end of World War II, these problems and many others were solved. The development of radar as an instrument of war progressed by leaps and bounds until radar emerged as one of the wonder weapons of the war. We all know how a string of radar stations along the English Channel permitted a greatly outnumbered British Air Force to win the "Battle for Britain" by directing the few available planes to the right place at the right time. Our naval success over the Japanese in the Battle of the Coral Sea was made possible by the use of radar. The German battleship Bismarck, by the use of radar was able to sink the British battle cruiser Hood before the Hood could fire its second salvo.

Some of the more important combat uses of radar are for detecting approaching enemy aircraft, and directing their interception. "Night Fighter" planes have radar gun-directing equipment which permits destruction of enemy aircraft in pitch black skies. Specialized, radar controlled bombing equipment permits bombing of unseen targets through fog and darkness. "Tail End" Charlie in the tail of an airplane gives warning of an enemy coming up behind. Submarines can be practically driven from the seas by radar carrying planes, in conjunction with other devices. Coastal gun batteries use radar to detect the approach of enemy ships, to aim the guns, and even to watch the shell speeding toward the target. Ships use radar for the same purpose, to warn of enemy aircraft, and to control the anti-aircraft guns. Modern fighting ships have not one, but several, specialized radar sets. Anti-aircraft batteries are controlled by radar sets that automatically follow the target, at the same time pointing the guns so that the exploding shell and the enemy plane arrive at a certain point at the same time. Other radar sets are used to identify airplanes or ships as friendly or enemy, as aids to navigation over distances of hundreds of miles, and as absolute altimeters on aircraft. Radar is used to detect and plot the position of enemy guns and mortars by getting "echoes" from the shells they fire. They can locate tanks and trucks. Radar is used to direct the flight of rockets and guided missiles, and to warn of enemy missiles approaching.

Since the end of the war, research has adapted radar to many peacetime uses. Lake and river steamers are equipped with radars which permit them to navigate with safety through fog and storms. They "see" their channel as in Figure 2. Ocean going vessels use radar to avoid collision, to get in and out of harbors in fog, to make landfalls. Large ports such as Liverpool are setting up radar control to guide vessels in and out of port. Loran, a radar navigational device, is used to guide ships through all kinds of weather over great distances. Airplanes are being standard equipped with a

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device that gives warning upon too close an approach to any object—ahead or below. GCA-Ground Controlled Approach—is radar used to land airplanes under conditions of zero visibility. Radar is used to detect the approach of storms and to predict the weather. There are numerous other uses for radar, and more are being developed every day.

Refer again to the "Radar" diagram, Figure 1, think once again how radar works, and then see how many new jobs you can find for radar. ●

"Salt of the Earth"

(Continued from Page 126)

child, is the belief that scattering a few grains of salt on a bird's tail will make it easy to capture.

It was a matter of religious principle with the Romans to see that no other dish was placed on the table before the salt was in position. Horace said: "He lives well upon little whose family saltcellar shines upon his frugal table". For the peasant, a shell served as a receptacle for salt; but at the repast of the wealthy citizen a silver saltcellar, usually an heirloom, was placed in the middle of the table. This custom prevailed in England in early times. Medieval saltcellars were often beautiful pieces of craftmanship. Until the end of the 17th century the rank of guests at a banquet was indicated by their seating in reference to the massive saltcellar. At the head of the table, "above the salt", sat the host and his more distinguished guests. The less noble sat "below the salt". In the 11th century, the laws of King Canute provided that any person sitting at a banquet above the position to which he was entitled should be "pelted out of his place by bones at the discretion of the company".

History records many illustrations of economic pressures exerted on peoples by lack of salt. It has forced them to wage war, to construct cities, to build ships, and to enter into commerce on land and sea. Some of the world's oldest trade routes were established for traffic in salt and incense, economic and religious necessities of the ancient world. One of the oldest roads in Italy, the Via Salaria, was constructed by Roman soldiers so that salt might more easily be brought to Rome from the salt works at Ostia, near the Mediterranean Sea. Many of the caravan routes through the Libyan desert were used to transport salt.

Salt has played a notable part in many military campaigns. During the Civil War the South obtained much of its salt from springs and deposits near New Orleans. The North succeeded in cutting off the region, much to the distress of the South. One of the principal purposes of one Union foray into Virginia was to capture Saltville, another source of salt for the Confederate States. Many Indian wars in central and western United States were fought to protect salt licks or salt springs. Sources of salt were few and widely scattered, consequently of great importance to the Indians who had to protect them at all cost. As the early settlers moved further west, the expense and danger of transporting salt from the east increased tremendously. Salt that was purchased for $3.00 a barrel in New York State could be sold in Ohio for $28.00, in Kansas for $56.00, and in the Dakotas for $84.00 a barrel.

Lack of salt played a part in Napoleon's retreat from Moscow. The death of large numbers of his soldiers is attributed to wounds which would not heal because of a prolonged deprivation of salt. Nowadays, millions of salt tablets are used by our armed forces and by hard working civilians to replace the salt lost through perspiration, thereby warding off fatigue.

Old manuscripts reveal that 5000 years ago in China, salt was obtained by evaporating sea water. Aristole mentions that the Umbrians obtained it by the same method. In the earliest times, shallow salt water-evaporating basins were operated along the shores of the Dead Sea. Most of the salt consumed in Biblical times was made there and carried into neighboring countries by camel and donkey trains. Soldiers were required to protect the caravans for they were subject to frequent attack. When Columbus first landed on our shores, he brought salt with him. It was solar salt from the Dead Sea. The early settlers in the new world had to import the salt they used.

The tribes of Indians that inhabited what is now central New York State obtained their salt from the Atlantic Ocean. Each spring, selected members of the tribes made the long, hard journey down the Mohawk and Hudson Rivers to the sea. They put ocean brine into containers made from the skins of animals and allowed the sun to evaporate the water. They had left what they called "magic white sand". It took them most of the summer to harvest enough salt to supply the several tribes until the next season. On their return in the fall their tribes received the salt makers with great rejoicing.

After the Indians who lived near what is now the city of Syracuse, N. Y., discovered the salt springs there, they no longer had to undertake the arduous journey to the sea. Their salt supply was close at hand, and fortunately, the brine was richer than the ocean brine. This meant power and wealth to the fortunate tribes. They no longer had to economize in their use of salt for seasoning, and for preserving their foods and the skins of the animals they used for clothing. Soon other tribes learned of the new source of salt, and they traded animal hides for the magic white sand. The Indians who controlled the supply became rich, powerful and aggressive. After General Sullivan's campaign against warring Indian tribes in central New York, a peace treaty was signed between the United States Government and the several tribes of Indians. The treaty

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provided for establishing an Indian Reservation, to be known as the Onondaga Indian Reservation and located near the city of Syracuse. The treaty contained a clause that requires that in October of each year the United States shall furnish and deliver at no cost to the Indians, 56 pounds of salt to each Indian on the Reservation. Payment is still made today, and the occasion is an important event for the Indians.

The first improvement in the production of salt came when the mining of rock salt was begun. About 1000 A.D., the world famous Wieliczka mine in Galicia, Poland, was discovered accidentally. It has been operated continuously since its discovery and its product has been shipped all over the world. Several times the mine has been the focal point of military campaigns.

Mineral or rock salt is mined about like coal. To be mined, salt must be at least 95 per cent sodium chloride. The ground, rock or shale formations above it must be tight to prevent the infiltration of water, for the salt must be dry in order to mine, crush, and screen satisfactorily and economically. Mined salt is about half as costly to produce as evaporated salt by the well method, consequently it is much used in the chemicals industries.

The birthplace of the salt industry in the United States is Syracuse, N. Y. Syracuse is called the saline city and Salina Street and Salt Road are important thoroughfares. It has been mentioned that salt was first discovered in this central New York region by the Indians. Later, a white man, Bishop La Moyne, learned of it from the Indians. Surprisingly, there is no rock salt under the city. The deposit is some 20 miles away near Tully, N. Y. From this deposit a salt brine seeps through the ground, and at Syracuse wells drilled to depths of 300 to 800 feet yield a brine that is 60 to 70 per cent saturated.

At first, the brine was heated in iron kettles to drive off the water and leave the salt. New York State assisted the early producers by guaranteeing them a fixed price for their product, based on a bushel measurement of 56 pounds of salt.

The first improvement in New York salt production was the introduction of solar evaporation. Pipes made of logs carried the brine to salt platforms, — wooden tanks about 20 ft. square and six inches deep, where the heat of the sun evaporated the water. The tanks had sliding wooden covers to keep out rain, which would dilute the brine and prolong the process. Each salt yard had a big bell, and night and day, whenever it rang, everyone ran to adjust the covers.

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Wyoming County, N. Y. In 1890, the Duncon brothers invented a vacuum pan method for producing table salt. Brine is evaporated in a partial vacuum, producing a fine cube salt, known in trade as table or dairy salt. Vacuum pans are now in use throughout the salt industry.

Nowadays, brine for the production of table salt is obtained by drilling a hole 8″ to 12″ wide to the bottom of a rock salt vein. Seepage of surface water is prevented by introducing a metal casing. Three-and-one-half inch tubing is inserted through the casing to the bottom of the drilled hole, and is then raised about 3 feet to permit the entrance of brine. Fresh water is pumped down the well to the salt between the casing and the inner tubing. The water dissolves the rock salt and forms a saturated heavy brine. The brine is heavier than the fresh water and because of its density finds its way to the bottom of the cavity formed by the dissolving of the salt, then up through the tubing, and through the transporting pipes into settling tanks. Production at first is slow, for the cavity is small and the fresh water has little surface to contact. This is overcome as the well is operated. Production increases until full capacity is reached, about 10,000 tons of salt a year. When, eventually, the roof of the cavity caves in, the tubing is broken and the well must be redrilled. Wells may cave in several times, but after a while caving near the tube ceases, but it takes place continuously at other points in the cavity too far away from the piping to damage it.

Deep well pumps have been used to withdraw the brine from the wells, but they are unsatisfactory because they agitate the brine to such an extent that many impurities are brought to the surface. These must be removed by filtering, which is expensive, or by long-period settling, or by chemical treatment. Nature will purify the brine in the settling tanks if sufficient time is taken. Lime or soda ash and trisodium phosphate may be added to the brine and the mixture allowed to settle. This more rapid procedure is useful in salt fields where alkalies are present in the rock salt.

After the crystallized salt is removed from the vacuum pans it is air dried or dried by the use of heat. It then goes to bins for storage or is put into packages for shipment. About one per cent of magnesium carbonate is added to table salt to prevent caking. Iodine may be added as a health measure if it is desired. In some sections there is a continuous demand for iodine packed salt. For cattle feeding, salt is compressed into blocks by air pressure. Iodine and sulfur may be added to it. ●

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Science Pupils Fail

(Continued from Page 129)

such as this, but he wouldn't teach any differently if he knew them. "My job," he says, "is to teach the physics and chemistry in this school."

Second, the teacher has never stopped to see the many applications of physics immediately at hand. He teaches sound immediately after heat. That's the way it comes in the book. To him that's reason enough so he looks no farther. It has never occurred to him that several of the pupils take music lessons. Several are victrola hounds. One of the local churches to which some of the pupils belong has just installed a new pipe organ. Some of the boys play in the school band. A local museum has an excellent exhibit on sound. The high school office has just bought a dictaphone. The speech teacher is trying to improve the voice quality of some of the pupils who appear to need it. The school doctor is examining several pupils for degrees of deafness with an audiometer. The phenomenon of sound is everywhere in the lives of these pupils but their physics experiences will leave them still unaware of it because of the lack of vision of the science teacher.

The pupils in physics have many needs, interests, aptitudes, lacks, prejudices. Certainly there is little learning of any kind without interest and a will to find out. A discussion of some of the things already indicated in the immediate environment would be almost certain to raise problems and kindle curiosity. Some planning by the pupils of ways to solve the problems would be in order. Assuming responsibility of providing materials such as musical instruments, home built equipment, etc. would be helpful to many of the pupils. They need experience in problem solving with problems that seem real to them, and with a little planning the experiences with sound could produce plenty of them. A field trip to the local museum carried out by the group affords opportunity to plan, observe, cooperate, question, take notes, gather data, and solve problems. A talk to the group by a local acoustical expert would provide a chance for gaining an applied physics slant, as well as experience in interviewing as a technique in gaining information. An investigation of the problem of reconditioning the auditorium to improve its acoustics has all sorts of learning by-products: how costs are figured, how materials are purchased, how funds are raised, etc. Correlating the learnings in physics with the work of the speech teacher might easily be responsible for both teachers coming to see that all teaching is effective only insofar as it serves the total needs of pupils, and that consequently there is something to be gained by joint planning. Valuable learning would result from several angles if the school doctor brought the audiometer to the physics class.

These are but a few of the opportunities the study of sound could provide for cooperative planning on the part of pupils. Opportunities for catering to the needs of individuals in the group, for increasing the vision of the importance of science in the everyday lives of the pupils, for critical thinking, for making some decisions, for relating ideas into a larger pattern of thinking and for many other similar outcomes result when the physics teacher begins to think of his subject as a tool for developing his pupils into well-rounded individuals in addition to giving them subject matter understanding. As he now teaches physics he reaches only a very few of the many pupils who might take his course were it not for the course's bad reputation. Of the number who do enroll very few like physics or see any application for it, and when they finally finish the course they prefer not to think of it again.

Do this science teacher's pupils fail? Let's ask our science pupils to tell us *how they feel* about their present science courses. Let's try to see what they really get from their exposure to science. Let's find out why such a large number of our pupils do not elect to take science if they are not compelled to do so, or take only the minimum requirements. Let's ask ourselves honestly what constitutes success or failure in our science courses. Do we actually believe that the study of science has something valuable to contribute to the total growth and development of boys and girls? If we do, we should make greater strides toward giving it a chance to realize its potentialities. Science teachers such as the physics teacher described in the foregoing are much too easy to find: our graduates by the thousands are still failing their science. ●

Biology Models

(Continued from Page 130)

nucleus should be made the same day as the basic molds, which will form the cytoplasm of the cells. They can be made later if necessary, but the outlined procedure is desirable so that the nucleus may be glued onto the cell and tinted with water colors. The models illustrated have a red band around the nucleus and are painted in tints ranging from blue to blue-green, greenish yellow, yellow, and back to greenish yellow and blue. This was done to suggest the subtle changes that might occur within the nucleus while it is dividing.

After painting, thread may be glued on to form a net for the first, seventh and final stages. Dark wool of varying thicknesses should be used for the chromosomes on the other nuclei. Brown is the best color, as it is softer than either black or navy blue. After the model has been fixed to its stand, a gray construction paper back may be glued on. Then a coat of white varnish is spread on the whole model, except perhaps the base wood, and the work is completed. The accompanying picture shows the finished models. ●

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Science—Learning vs. Using

(Continued from Page 118)

amples. It may be argued that science training has direct application in modern life; and so it has, but not unless the student goes on into scientific work. And for this student, is it any *less* important that he learn to think straight and reach sound conclusions? How then can we best attain this evidently desirable objective?

First of all, if mental training really is the paramount object of elementary science courses, let us start by doing some straight thinking ourselves: set up this object as the goal and criterion for all incidental subject matter and method. Thus, to paraphrase Lincoln's famous letter to Horace Greeley, if all the possible aids mentioned at the beginning of this article would significantly help to attain the one object of mental training, I would use them all. If none of them would serve that one purpose, I would discard them all. If such a purpose were shown to be best served by using some and discarding the others, I would do that.

In putting the matter thus strongly, no disparagement is intended of other clearly desirable objects; but primary emphasis is put on the opportunity and importance of student *use* of science in his own mental development.

With this yardstick, most of the questions originally posed almost answer themselves. Facts, principles and results of science can all be made effective to any extent that the student can be got to use them effectively in his own mind. Neither is it too important what means of presentation be chosen, providing it complies with the requirement of mental use. And, as already indicated, the word use implies more than mere learning or even understanding in the static sense. It means working with the ideas, doing something with them, which is incidentally the best road to learning and understanding. With that requirement met, there is no longer much distinction between facts, principles and results; for principles are only organized (thought out) facts from which results, in the form of new facts, follow.

Here the reader may quite properly ask what science do I have in mind? It could be any one of several, including a general science course; and mathematics, the tool of all science. But I must confess that I am thinking more in terms of physics than of any other. With its underlying principles of force, motion, mass, energy, sound, light, and electricity, physics seems so much the basic science as to make it, with mathematics, a 'natural' for anyone going into science at all.

But enough of generalities. Illustrative examples do not have to be "cooked up" these days; they are all around us. Every teacher who has hobbies, or who merely keeps his senses alive, knows what I mean. Why do you let your hands hang down in a normal walk, but raise them more and more as the pace quickens? Why do you turn a bicycle by first starting a turn in the wrong direction? Why does leaving the door of the electric refrigerator open fail to keep the kitchen cooler? We are closer to the sun in winter; why isn't it warmer then? Or take an example from my own specialty, aeronautics*—a veritable mine of the facts, principles and results of basic science:

The vertical forces acting on an airplane in straight level flight can be set up as gravity or weight and an equal and opposite aerodynamic lift. Shall we consider gravity as a simple *fact* of nature, a *principle* or law which Newton deduced from Kepler's astronomical data, or a *result* of applying special conditions to Einstein's General Relativity? Similarly the lift can be shown experimentally to be in most cases a simple linear function of the wing's "angle of attack" and proportional to the air density and the square of the speed. It is also, by Prandtl's application of Newton's principle, equal to the downward momentum (per unit of time) imparted to the air passing through a vertical circle set up on the wing span as a diameter. Then of course there is the derivation of the latter principle and its various results, not to mention the many refinements and elaborations of theory (effect of wing planform, section, etc.) pursued by aeronautical engineers.

So it appears that this elementary balance of two forces *could* be made the basis of several science courses, an obvious absurdity for the general student in secondary school. To quote Dean French of Colgate, "If scientists (themselves) were to await the complete background of facts before taking a step forward in theory, the progress of science would be measured in geological time." For present purposes, the necessity of picking out a few simple, but connected, factors to work with is obvious; these can be set up in any form that poses a problem to be solved, a result to be sought, or a proposition to be proved, in fact almost anything that gives the student a mental "workout" and actively challenges his understanding .

Any real aid to such understanding cannot be lightly cast aside. Slide films or movies showing airflow paths or streamlines, smoke streams, floating particles on a water surface, a simple airfoil balance in an airstream from a fan can all for example be made to illustrate the physical principles governing airflow. A resourceful teacher will naturally think of many such aids; and an aggressive teacher will provide the ones he wants without waiting for someone else to take action.

But it is easy to overestimate the importance of such aids; and, unwisely or too frequently used, it is easy to make them a liability instead of an asset. It is all too easy for a teacher, and for a student, to let a picture or a model do his thinking for him. Habit, reinforced by successful demonstrations and by the desire to cover more ground, gradually takes charge; and soon we have another "pipe" course, which may be popular and even interesting, but which has little of more lasting value than a set of Superman comics.

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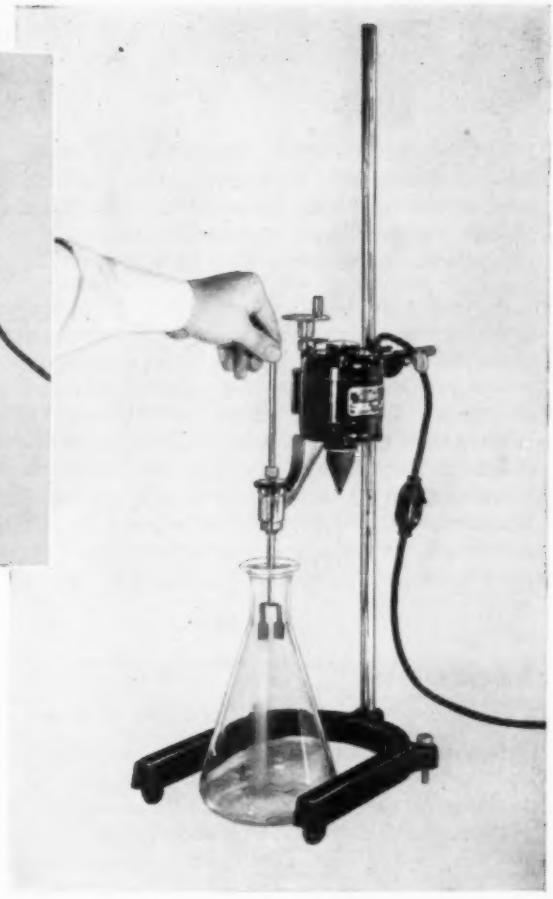

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Real science, unused, is little better than pseudo-science. If we are to have anything like scientific supermen, it will not be by dreaming, by watching a science parade, or even by learning great truths, but by using all these things for individual mental development.

A final word seems called for. It is appalling how many of the highest achievements of science are being employed for destructive, rather than constructive purposes. But, with perhaps one notable exception, responsibility for the *use* of science in this sense is largely outside the province of science itself, as ordinarily understood. The military use of atomic energy in no way detracts from its importance as a scientific event; but it emphasizes the still greater importance and real responsibility of the higher controlling forces that should govern the lives of men and of nations. ●

Isotopes

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Applications to Biochemistry

In the field of biochemistry isotopes have been used for many years in tracer experiments, so that it is not surprising to find that most biochemical texts contain numerous examples of such work. Yet, a full appreciation and understanding of these experiments may not be attained by students using such books. In the first place there is a tendency on the part of some authors to treat isotopes in biochemistry as mere tools, with only brief mention that certain facts have been discovered by means of tagged atoms. Not enough details are provided to allow the student to picture such operations as how the tagged compounds were prepared, and what properties of the isotopes permitted them to be traced during their metabolism. It would be desirable to select from the literature a simple and brief radioactive tracer experiment, and to describe it in terms which would be understood at the student level. Another typical example could be chosen which made use of a stable isotope. Then the student would have at least some understanding of even brief mention at any place in the course of additional experiments with different isotopes.

Another factor which tends to emphasize the briefness mentioned above is the fact that many authors of biochemical texts assume that the student is well grounded in his knowledge of isotopes. This is implied from the lack of introductory statements about the nature of isotopes. However, as mentioned previously in this paper and elsewhere,[1] there is a strong possibility that some students may obtain little more than a definition and brief explanation of isotopes in freshman chemistry and little or no mention of this topic in organic chemistry, depending on the texts used. By the time such students reach the study of the biochemical applications of isotopes they may have forgotten the very meaning of the term. Such students may understand the results of tracer experiments, but they can hardly have a mastery of the principles involved in arriving at the conclusions.

As an exception to the lack of introductory material in texts, *Practical Physiological Chemistry*[3] is outstanding. In this book eight pages are devoted to an excellent, complete, and up to date treatment of isotopes. A review of atomic and nuclear structure and chemical properties of elements is followed by sections dealing with radioactive and stable isotopes and their uses in biological investigations. A striking feature of this discussion is to be found in its critical evaluation of the

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advantages and disadvantages of the various investigative procedures available for radioactive and stable isotopes, including such factors as availability, cost, half-lives, type of radiation, errors involved in detection and measurement, and various limitations. All these points, brought out in a concise but complete manner, provide the students with a thorough background for understanding the various applications of isotopes which are treated throughout the text.

Applications to Other Courses

It would be difficult to find a chemistry course whose content has not been influenced either by the existence of isotopes or by their use in furthering knowledge of particular fields. If instructors in the various courses will introduce some of this subject-matter in the class room to a greater extent than is now common, students will be able to study isotopes more completely than they can at present. For instance, stable isotope exchange reactions and their equilibrium constants can be studied in physical chemistry as a topic under the general heading of equilibrium. Also in physical chemistry, or in specialized courses dealing with chemical kinetics, there is ample choice of topics suitable for student consideration.[4] Applications of tracer isotopes in the field of analysis are very numerous. Examples of studies on solubility, efficiency of separation, distribution between immiscible solvents, coprecipitation, and surface properties of precipitates have been collected in an excellent review.[5] The teacher of even elementary quantitative analysis will find that many of the techniques used and results obtained are well within the grasp of his students. Further examples in still other courses could be cited.

Progressive teachers who are alert to the contributions which are being made to their respective special fields of chemistry by means of isotopes have a marvelous opportunity to teach their students many things about some of the productive and peaceful fruits of this age of atomic energy. ●

LITERATURE

1. Gorman, Mel "Isotopes in Freshman Chemistry," *Science Counselor, 11,* 9½ (1948).

2. Porter, C. W., and T. D. Stewart, *Organic Chemistry,* Ginn and Co., New York, 1943.

3. Hawk, P. B., B. L. Oser, and W. H. Summerson, *Practical Physiological Chemistry,* The Blakiston Co., Philadelphia, 1947.

4. Daniels, F., *Chemical Kinetics,* Cornell University Press, Ithaca, N. Y., 1938, pp. 257-262.

5. Flagg, J. F., and E. O. Wiig, Tracer Isotopes in Analytical Chemistry, *Ind. Eng. Chem., Anal. Ed., 13,* 341-345 (1941).

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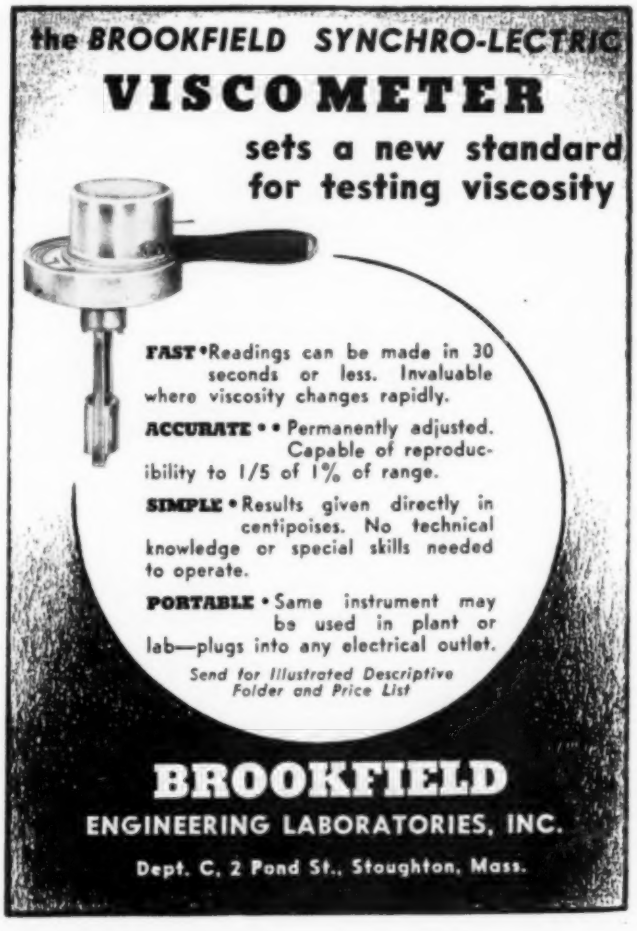
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Sunspots

(Continued from Page 120)

rest assured that long distance radio communications are being badly interrupted. Sometimes not only hours but 4 or 5 days may elapse before sufficient electronic stability has been regained to bring back distant radio programs to their normal quality.

Much can be learned about the effect of sunspots upon the earth's upper atmosphere by measuring the strength of radio waves regularly received over a distance, and watching their behavior day in and day out, year in and year out, throughout a whole sunspot cycle. The Cosmic Terrestrial Research Laboratory associated with the Massachusetts Institute of Technology at Needham, Massachusetts, operates many field intensity recorders. These tell just how strongly a radio wave is being received from a distant station throughout 24 hours of every day. In almost an uncanny fashion, the pen of an automatic recording device slides to and fro along a roll of recording paper that slowly unwinds throughout each hour of the day. A study of long-accumulated records of this laboratory has shown that over a given distance for a given frequency, there is a well-recognized metamorphosis in the type of reception received throughout the 24 hours of the day that progresses with the sunspot cycle.

During years of low sunspot activity, there is a well-recognized seasonal change from summer to winter in the reception of the Bureau of Standards standard frequency signal WWV on 5 mc. received at Needham over a distance of 370 miles. The daily pattern is characterized by high fields in early morning and late afternoon with low field intensities during the night and during the middle of the day. In the summertime, on the other hand, the diurnal pattern is characterized by high night fields and low mid-day fields. This may be explained by the heavy absorption introduced by the much more heavily ionized E layer characteristic of the long summer days with the sun riding high in the heavens. During the sunspot rise from 1944 to 1947, the summer pattern became the dominant picture of our daily field strength variations the year around. From the time of rapidly rising sunspot numbers in the latter part of 1946 until midsummer of 1948, we had had the persistence of the summer pattern with high night fields and low day fields on this 5 mc. frequency. This may be explained by the fact that accompanying many sunspots, the sun's ionizing radiation was sufficiently intense to more than compensate for the shorter days of winter with the lower solar altitudes of the winter months.

Such records of continuous measurements of field intensity patterns become increasingly important in anticipating how well communications can be received at given frequencies over given paths throughout the sunspot cycle. This helps radio engineers to determine when and how wave lengths or frequencies should be switched to compensate for the sun's behavior pattern to insure minimum interruptions to important communications.

In addition to actual field intensity measurements which give an index of performance of how radio waves are received, the National Bureau of Standards at Washington and many associated stations throughout the world are continually sounding the ionosphere by means of radio pulses to determine the number of electrons present at the reflecting layer every hour on the hour in various parts of the world. Knowing the electron density or ionic concentration at the critical heights of the E and F layers, it becomes possible in a way to predict how far a wave of given frequency may be transmitted effectively and also to tell broadcasting companies and commercial radio industries what wave lengths to use to reach any part of the world at any time of the day or night. ●

Whole Education

(Continued from Page 122)

ing investigations on which the book is based were made possible by the generous material support and active participation of the Board of Directors of the Hebrew Technical Institute of New York City, a group of men who have realized the benefits of the vocational education they received in their Institute and are keen to extend those benefits to others.

Often the classroom teacher or the administrator looks at a book like this and dismisses it regretfully as presenting problems too large for his small sphere of influence. Yet, he need not despair, for there is hardly a recommendation that he cannot carry out on a small scale. To mention only three: Whether he teaches science, literature, history or any other subject, he can in some way motivate it through the current or potential occupational interests of his pupils. Again, whatever the subject, he can devise ways of enabling his pupils to *do* something about, with, or for it. And finally, through his adult contacts with men and women in industry, business, and agriculture, and other occupational fields, he can open the way for school leavers to find jobs of their choice, in which they are likely to succeed. Thus he will contribute to the whole education of complete Americans. ●

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"The Challenge to American Education"
New York Times Magazine

The Radio Tube

(Continued from Page 125)

school groups have visited the Calculator. Their reactions justify the belief that this new and developing science can increase their appreciation of mathematics. The boy or girl who today is playing with magic squares may well be the scientist who tomorrow will be solving a problem essential to the survival of our civilization. ●

★ ★ ★ ★ ★

"We are prone to think of education . . . as being synonymous with schools and colleges. It is time we flung that narrow concept out the window. Education does not mean school buildings and school systems. It does not mean instruction, though that is a part of it. It does not mean only knowing the answers. In my definition, education means seeking for reason, wisdom, and understanding—the drawing out of all that lies behind the human facade."

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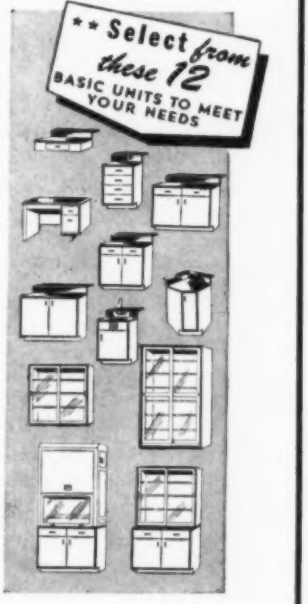

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Ivan Ray Tannehill, United States Weather Bureau, Washington, D.C. President, Commission for Synoptic Weather Information, International Meteorological Organization.

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Columbium Nitride and the Bolometer
Donald H. Andrews, Department of Chemistry, Johns Hopkins University, Baltimore, Maryland.

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Audio-Visual Aids
E. DeAlton Partridge, Dean of Instruction, State Teachers College, Montclair, New Jersey.

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The Place of Comets in Modern Astronomy
Joseph Ashbrook, The Observatory, Amherst College, Amherst, Massachusetts.

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Special Problems in Secondary-School Science Teaching
Vernon C. Lingren, School of Education, University of Pittsburgh, Pittsburgh, Pa.

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Saul Moses, Naval Research Laboratory, Washington, D. C.

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E. T. McBee, Department of Chemistry, Purdue University, Lafayette, Indiana.

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Joseph Samuel Hepburn, Professor of Chemistry, Hahnemann Medical College and Hospital, Philadelphia, Pa.

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Biology—What and How
James C. Adell, Chief, Bureau of Educational Research, Board of Education, Cleveland, Ohio.

•

One World of Science
F. R. Moulton, Administrative Secretary, American Association for the Advancement of Science, Washington, D. C.

Middle America

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crops were to compete successfully in the world market. Therefore, in 1944, the Company established the Escuela Agricola Panamericana* at Zamorano, 25 miles from the capital city of Tegucigalpa. The first class of 74 students was carefully selected. Its members came from Nicaragua, Mexico, Guatemala, El Salvador, Panama, Costa Rica, as well as from Honduras. Capacity enrollment is about 170.

The whole student body is made up of scholarship students, no tuition being charged. An intensive three-year course, divided between classroom and field, gives the future Middle American farmers a thorough grounding in the latest methods and techniques of tropical agriculture. To build and endow the school involved an expenditure of $2,000,000 by the Company, which derives no direct benefit from the enterprise. The students are in no way obligated to the Company upon graduation—in fact, they are encouraged to go back to their homelands and make available to their fellow-countrymen the technical knowledge they have gained.

For a land to be productive it must be healthy. Great areas once only malarial swamps have been changed into productive banana lands. Fighting swamps and jungles meant also fighting tropical disease, and since the beginning of its operations in Middle America, vast sums have been spent on sanitation, hospitalization, and health instruction. Its 13 hospitals and 101 field dispensaries treat a total of 200,000 patients every year.

Thus progress is made. Middle America can still be said to be an experiment station on a huge scale, but the program of development planned by the Company's Department of New Crops, is on a permanent basis. Progress must of necessity be slow, yet astonishing results have already been obtained. The long-range aim to build on a firm foundation has not been lost sight of. As Samuel Zemurray, then president of United Fruit, wrote in 1945: "The economic and social evils of a one-crop or two-crop economy must not be fastened on Middle America." Thomas Dudley Cabot, who recently succeeded Mr. Zemurray, has been quoted as saying: "This diversification helps the economy of the countries involved by providing a continuing cash income when banana plantations are blighted by Panama disease." •

**The Science Counselor*, IX, 104.

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